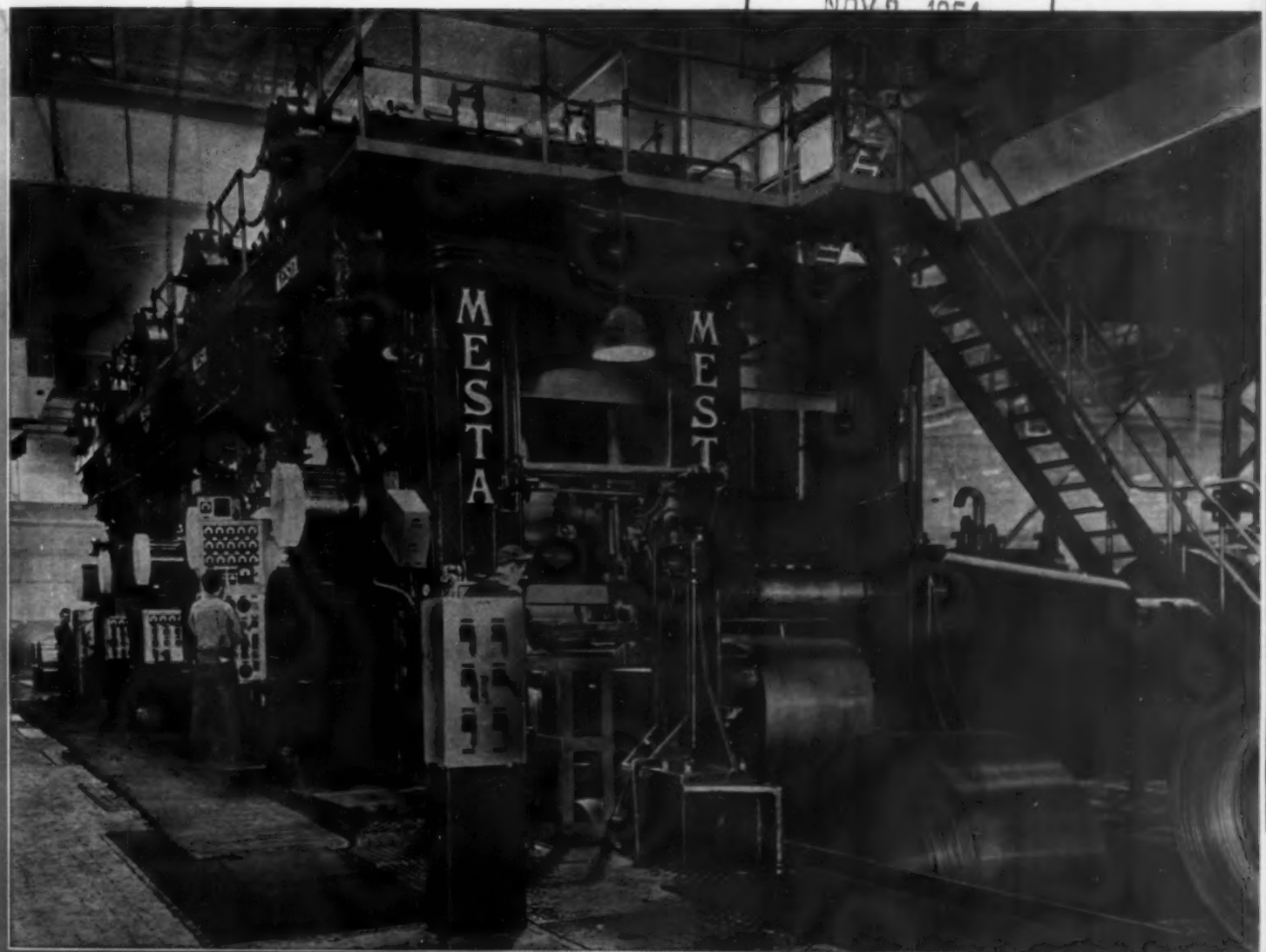
Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

OCTOBER, 1954

PUBLIC LIBRARY
NOV 8 1954

TABLE OF CONTENTS, PAGE 53



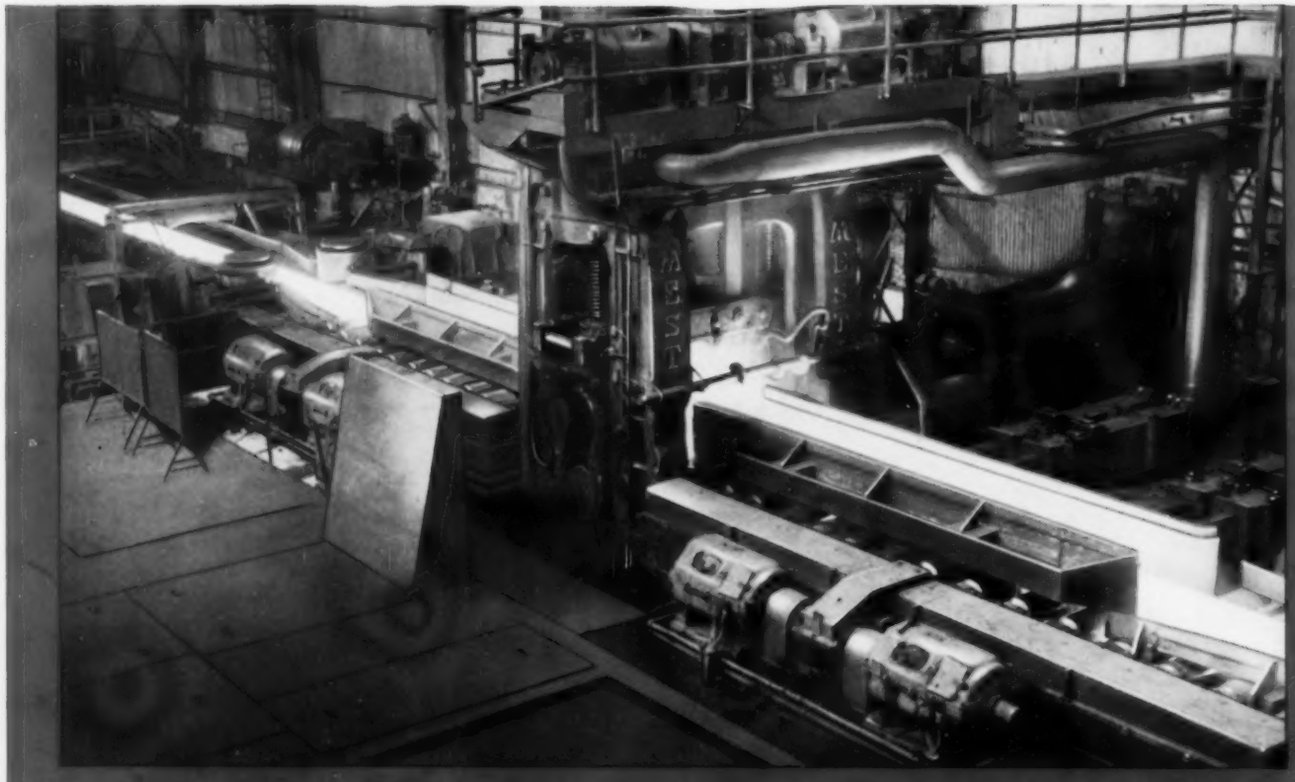
Mesta 48" Four-High, Five Stand
High-Speed Tandem Cold Mill

Designed and Built by
MESTA

The World's *HIGHEST SPEED*
Cold Mill
FOR FAIRLESS WORKS,
U. S. STEEL CORPORATION

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY PITTSBURGH PENNSYLVANIA



Outdated mill modernized— by low cost control redesign

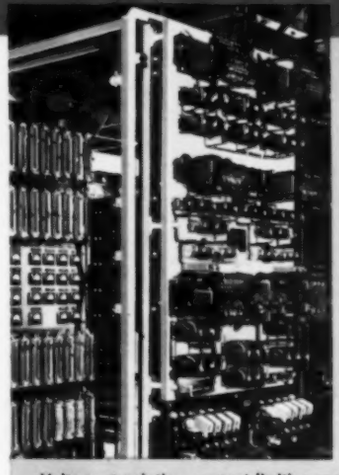
Timely engineering saves time, money and increases production

The 38″ Blooming Mill above was built in 1928 to roll aluminum. In 1950, it was transferred to the Empire Steel Corp. works at Mansfield, Ohio, to roll steel slabs. This conversion to steel rolling service and the inherent increase in rolling horsepower required brought immediate problems. Mill reversal was sluggish, on the order of 4 seconds. The tremendous impact current inrush upon the generator, caused very unsatisfactory commutation.

The Empire people considered several solutions. But they also consulted Cutler-Hammer, builder of the original electrical control for this mill. Cutler-Hammer recommendations were different, and simple, and accepted. Without change to the mill or its 5000 horsepower d-c motor, Cutler-Hammer replaced the 9-step, current-relay, rheostatic-type control with a voltage-regulating, current limiting magnetic amplifier, and added a permanent step of armature circuit resistance.

The results were "astonishing." "Down" time has been virtually eliminated. Reversal time has been cut from 4 seconds to 2 seconds. Current inrush during impact speed-drop has been cut almost 30%—to well within safe commutation limits. And the total cost of the tremendous performance improvement was only a fraction of the estimated cost of other solutions.

The tremendous scope and competency of Cutler-Hammer engineering ability, fostered by close contact with steel-mill problems ever since 1892, are available to you on any proposed mill installation. Typically, Cutler-Hammer gains the results you want by efficient application of sound engineering practices to produce electrical drives that install easier, work better, and last longer. For complete analysis of your control applications—look to CUTLER-HAMMER, Inc. . . . 1269 St. Paul Avenue, Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.



Voltage-regulating, current-limiting magnetic amplifier provides smooth regulation during acceleration and deceleration. Its forcing action cuts reversal time to 2 seconds.

Permanent step of armature resistance compensates for electrical sluggishness of existing machines and with magnetic amplifier reduces impact speed-drop current inrush almost 30%.

CUTLER-HAMMER
MOTOR CONTROL
C-H

LOOK TO CUTLER-HAMMER MILL EXPERIENCE . . . AS BROAD AS IT IS LONG

IRON AND STEEL ENGINEER: published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 31, No. 10

with LINDE Oxygen you get the BIG PLUS

. . . that's LINDE SERVICE

In every metalworking operation, new materials, changing requirements, and unexpected emergencies create special situations that demand skill and experience.

That's where LINDE SERVICE comes in. LINDE's field engineers stand ready to help you meet such conditions. They're backed by LINDE laboratories, where research in oxygen manufacture, distribution systems, and application methods has been carried on for more than 40 years.

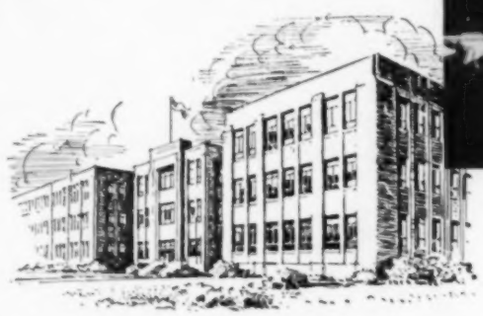
When you use LINDE Oxygen, you're also getting, when you need it, practical advice and engineering service that can't be matched anywhere else.

AT WORK—FOR YOU

At the LINDE Laboratory, research is constantly under way on time and money saving methods and materials for utilizing oxygen and oxy-acetylene processes.

LINDE SERVICE

is the unique combination of research, engineering, and more than 40 years of accumulated know-how that is helping LINDE customers save money and improve production in their uses of oxygen and oxy-acetylene processes.



If your company uses oxygen, LINDE SERVICE can mean dollar savings to you. Let us tell you how.

LINDE AIR PRODUCTS COMPANY

Division of UNION CARBIDE AND CARBON CORPORATION

30 East 42nd Street UCC New York 17, N.Y.

Offices in Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

Linde Trade-Mark

Up-to-the Minute Facilities for Machining and Finishing

In this large area machine shop National rolls receive their finishing touches—and only the most modern machine tool equipment is used to assure precision. There are roll grinders for both rough and finish grinding, a battery of 40-inch rough turning lathes, as well as an 8′ x 22′ Ingersoll Milling machine, a large radial automatic feed drill press, an 8′ x 67″ x 36′ stroke planer, plus many smaller but equally modern machines.

With these excellent machining facilities, you are assured of precision finishing in every National Roll you buy.

THE NATIONAL ROLL & FOUNDRY CO.
AVONMORE, PENNSYLVANIA

SPECIALISTS IN IRON, ALLOY IRON AND STEEL ROLLS AND CASTINGS, STEEL ARMOR CASTINGS

WE HARNESS UNSEEN FORCES...

TO GIVE YOU GREATER LIFTING POWER!

The lifted load takes on a "new look" when you swing an EC&M Type SW ALL-WELDED MAGNET into operation. Each lift is wider . . . heavier . . . and a greater pay load.

This *greater* lifting power results from the EC&M all-welded design, which permits better space proportioning for magnet windings and eliminates load-limiting air gaps. When you turn on the current, invisible magnetic lines of force flow radially out from the center pole across the load and back into the magnet case through the outer pole ring. The magnetic path is constant . . . no air gaps at pole shoes.

Whether you are handling pig or scrap iron . . .or any other ferrous materials or products . . . there's an EC&M Type SW all-welded magnet to meet your individual requirements.

CHECK THESE FEATURES: EC&M Type SW all-welded magnets are sealed against moisture . . . inner and outer poles are welded for snug fit . . . pole pieces are renewable . . . wider working surface and bigger pay loads result from elimination of recesses for bolts . . . greater mechanical strength withstands rough handling and assures longer service life . . . maximum operating efficiency means substantial savings in time and results in top economy.

FOR DETAILS AND SPECIFICATIONS, WRITE TODAY FOR BULLETIN 900.

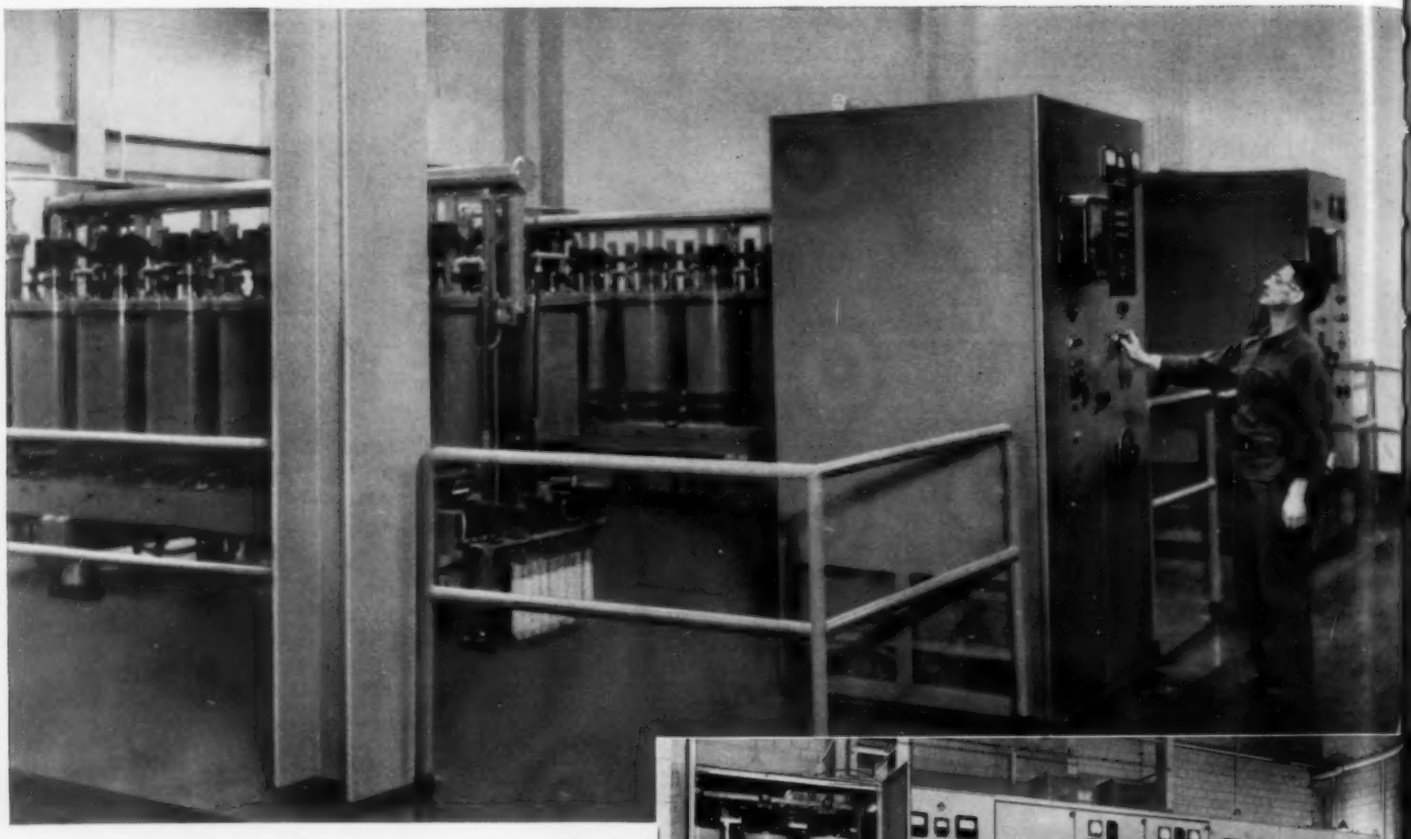
LIFT MORE FOR LESS WITH EC&M LIFTING MAGNETS!

1702

THE ELECTRIC CONTROLLER & MFG. CO.

2698 East 79th Street Cleveland 4, Ohio

100% DC Power for



BILLET MILL RECTIFIERS: Two 1500-kw, 250-volt rectifiers supplying dc service to cranes and runout tables in 30 and 21-inch Billet Mills. Rectifiers are provided with automatic control and provisions for starting and stopping by manual or remote control.

*6 OUTSTANDING RECTIFIER FEATURES

1 **Continuous Excitation:** pilot arcs always present. Eliminates need for synchronized re-ignition. Enables rectifier to ride through severe ac voltage disturbances.

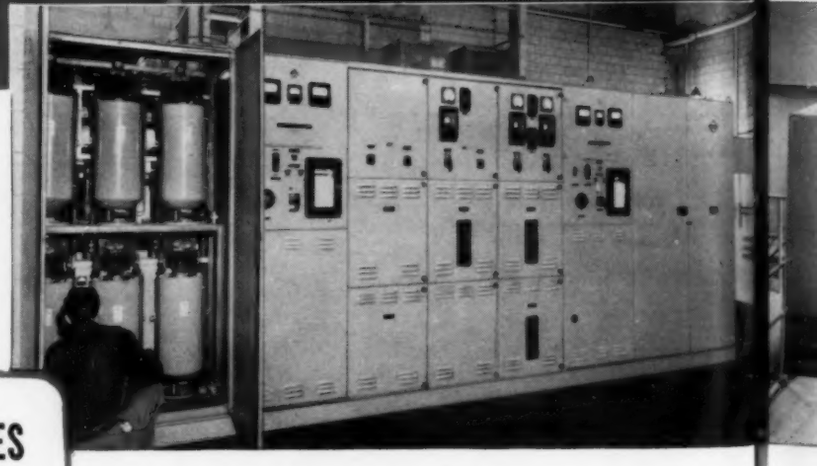
2 **Fixed Excitation Anode:** doesn't contact cathode mercury and is independent of level, turbulence or impurities . . . requires no adjustment, maintenance or replacement.

3 **Internal Cooling System:** high heat transfer with seamless tube cooling located within the rectifier.

4 **Enameled Anode Seals:** multi-layer fused vitreous construction provides high-strength seal unaffected by thermal variation.

5 **Grid Phase Control:** in cleaner region near anode, where ion density is lowest.

6 **Arc-over Free Tube:** insulating entire arc path eliminates danger of arcing-over to tube.



COKE PLANT RECTIFIERS: One of two 500-kw, 250-volt metal-clad rectifier units supplying dc service to coke plant pusher and coke handling equipment in Coke Oven area. Units are factory assembled and wired, complete with dc switchgear and transformers.

ALLIS-

FAIRLESS

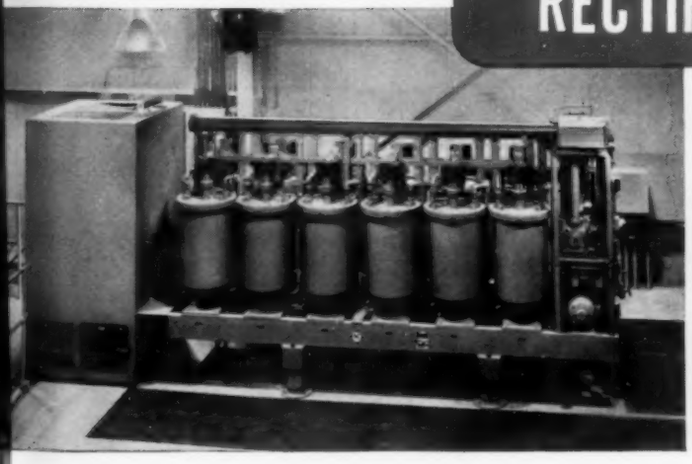
Material Handling

At Fairless Works of the U.S. Steel Corporation — the world's newest and most modern steel mill, continuous dc service is essential to material flow. Any interruption in this critical power supply would cause serious equipment damage and heavy production losses throughout the entire mill. Here, as in other mills over the United States, Allis-Chalmers mercury arc rectifiers are backing up their reputation for continuous, trouble-free operation under variable operating conditions.

In dc load centers located strategically throughout this gigantic plant, 19 Allis-Chalmers rectifiers produce *all* the 250-volt dc supply for every material handling operation . . . from unloading the ore to stockpiling finished steel. These rectifiers are designed and engineered for steel mill duty, and offer highest service reliability and efficiency with low maintenance features necessary for maximum mill output.*

For the same dependable dc service in your mill, specify Allis-Chalmers mercury arc rectifiers. Call your nearest A-C sales office for complete information, or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-4302

ALLIS-CHALMERS
MERCURY ARC RECTIFIERS



OPEN-HEARTH FURNACE RECTIFIERS: One of two 1500-kw, 250-volt rectifiers supplying dc service to cranes, pig casting machines, bailer, slag cars, and stock house equipment. Provided with automatic control and provisions for starting and stopping by manual or remote control.

RECTIFIER TRANSFORMERS: Two 13,800-volt outdoor transformers feeding two 750-kw, 250-volt rectifiers in Central Maintenance shop. Rectifiers supply dc service to maintenance shop cranes, machine tool equipment and provide auxiliary power for electronic testing devices and welding machines.

CHALMERS

A-C ALLIS-CHALMERS

Our Engineers Introduced Mercury Arc Rectifiers to U.S. Industry

MAINTENANCE SIMPLIFIED

Only one simple maintenance adjustment is ever needed after installation of CLARK Bulletin 106 DC Shoe Brakes. A quick glance at a gauge rivet conveniently located on top of the brake indicates when adjustment is required. By loosening two lock nuts and turning an adjustment bar—all readily accessible on top—the brake is easily returned to its original setting, with correct shoe clearance, magnet air gap and torque setting.

CLARK DC SHOE BRAKES *require only one adjustment*— and that's ON TOP

You don't have to be a contortionist to make the ***ONLY*** adjustment necessary on Clark Bulletin 106 Shoe Brakes. This ***ONE*** adjustment, compensating for lining wear, is made ***ON THE TOP***—not on the bottom, nor on the sides, nor on the ends—***JUST ON THE TOP***—that's where you can see it, and get at it easily.

These brakes are designed to fit the 600 series Type Mill Motors . . . They operate on the "nut-cracker" principle, providing equal distribution of forces —and safe, dependable operation.

CLARK Bulletin 106 Brakes are simplest to adjust and extremely easy to install.

Your nearest ***CLARK*** *representative will gladly consult with you on Brake problems.*

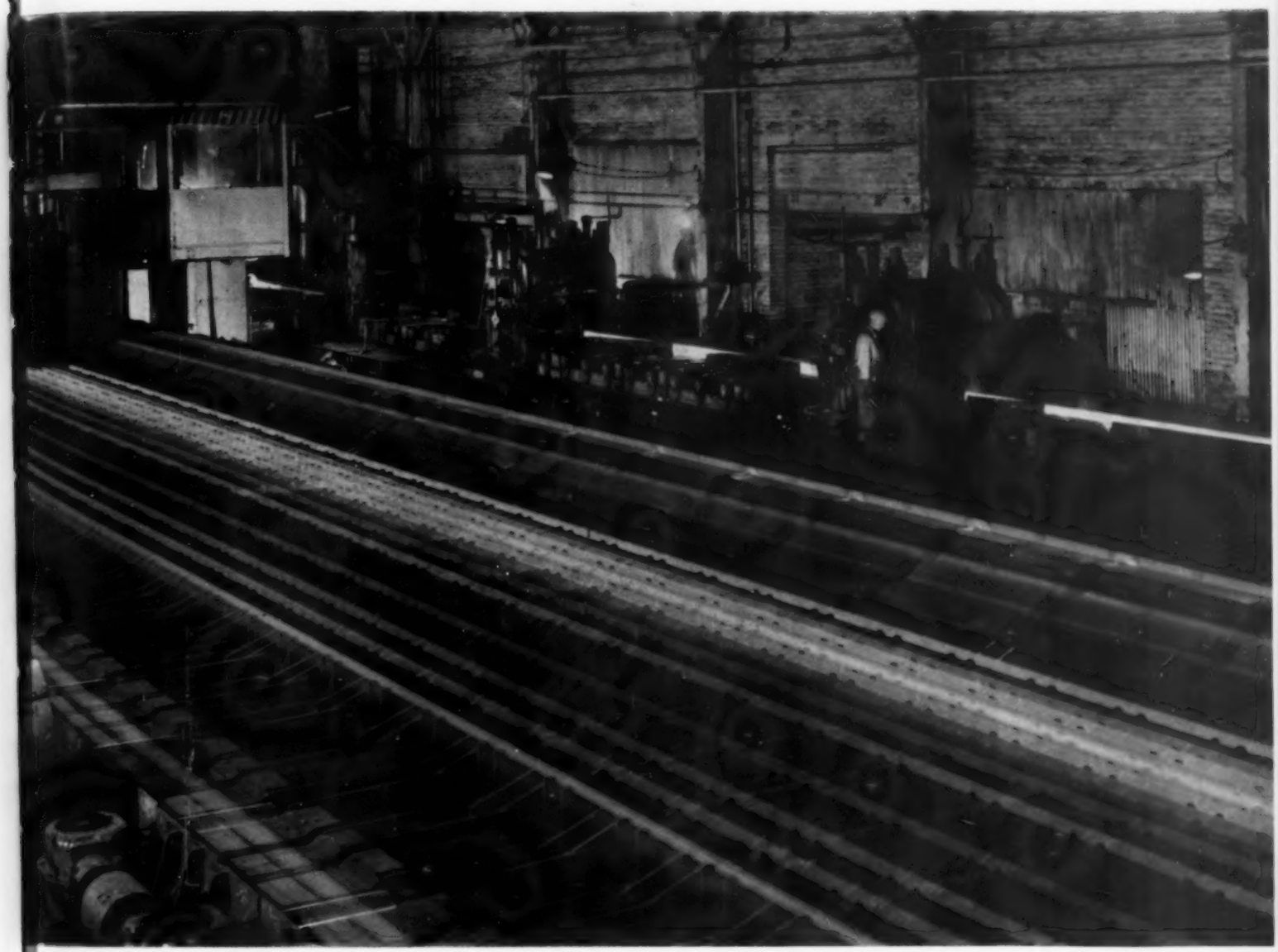
The **CLARK** **CONTROLLER** *Company*

Engineered Electrical Control

1146 East 152nd Street • • Cleveland 10, Ohio

CONTINENTAL

MERCHANT BAR MILL



How to Insure Performance When You Build a Rolling Mill

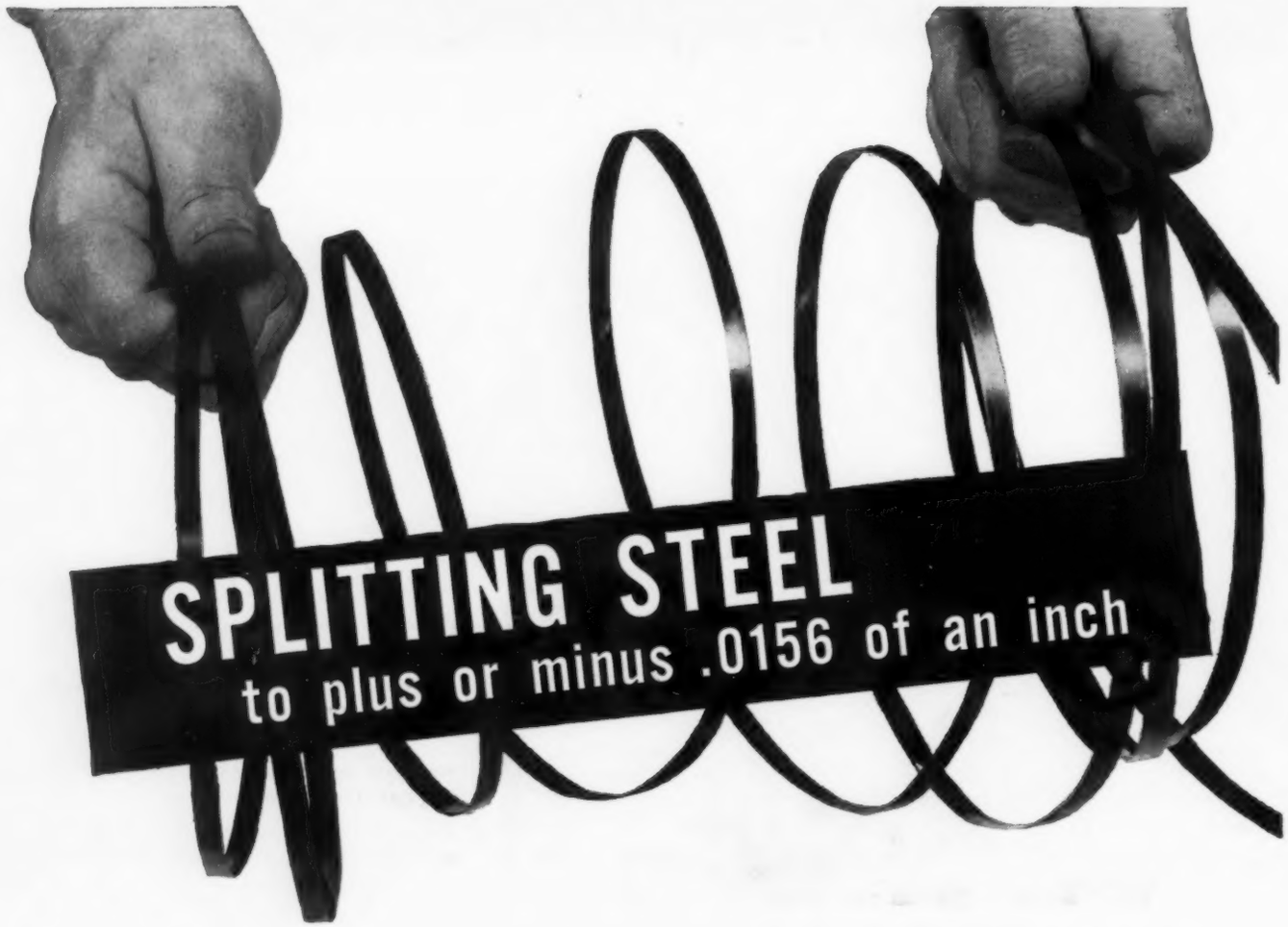
The definite and predictable performance of Continental Rolling Mills is a result of Continental's highly integrated organization and facilities. Under a single management you are served by competent engineers and designers—by complete facilities for producing every component—for assembling and testing—plus field installation that ends only when expected mill performance is a reality. More and more steel leaders are looking to Continental's complete service and undivided responsibility for their best assurance when building a mill.

- COMPLETE ROLLING MILLS
- ROLLS • ROLL LATHES
- CONTINENTAL CHIPPER
- SPECIAL MACHINERY
- STEEL CASTINGS • WELDMENTS
- COPES-VULCAN BOILER CONTROLS AND CLEANING

Plants at
East Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.
Copes-Vulcan Division, Erie, Pa.

CONTINENTAL
Foundry & Machine
Company

CHICAGO • PITTSBURGH



with ASKANIA Edge Position Control

A Pittsburgh district steel mill slits this ¼" rough edge from 15-ton reels of blackplate at 3,000 feet per minute with accuracy of ± 1/64". They do this precision edge-positioning job with Askania Hydraulic Edge Position Control.

Askania Edge Position Control is a new use for the Askania Jet Pipe Regulator, long the educated muscle of the steel mill. Steel men asked for it, because they needed the dependability and simplicity of Askania in this control job.

Nothing touches the steel but a stream of low pressure air. Available force is practically unlimited. The equipment is low in cost. There is nothing delicate about it. It's built to take all the abuse that continuous operation in hard service can give it.

Find out now about Askania Edge Position Control. See your Askania Representative, or write for Bulletin 161.

ASKANIA REGULATOR COMPANY
246 E. Ontario Street, Chicago 11, Illinois
A Subsidiary of General Precision Equipment Corporation

Motorists: here's proof...

Gulf's cleaner-burning, super-refined gasoline solves today's No. 1 engine problem!

This lamp is burning the "DIRTY-BURNING TAIL-END" of gasoline which GULF refines out
This lamp is burning NEW SUPER-REFINED GULF NO-NOX, the cleaner-burning super-fuel

Laboratory tests promised...

. . . these *immediate* and *lasting* benefits from this new, super-refined fuel:

More complete engine protection than from the so-called "miracle-additive" gasolines. Why? Because Gulf refines *out* the "dirty-burning tail-end" of gasoline (the No. 1 troublemaker in high-compression engines)—and then treats this new Super-Refined NO-NOX to give it a *complete range of protective properties*. It protects *every* part it touches against carbon, rust, gum.

Extra gas mileage in all your everyday, short-trip, stop-and-go driving.

No knock, no pre-ignition. Why? Because the anti-knock power of new Gulf NO-NOX has been stepped up to an all-time high.

Stall-proof smoothness. Instant *starts*, too—and fast, fuel-saving warm-up.

That's why new Super-Refined Gulf NO-NOX gives your engine more power-with-protection than you've ever known.

Road tests proved...

These cars, powered by New Gulf No-Nox, actually performed better than new . . . after 15,000 miles!

True! After 15,000 miles per car—covering all conditions of city and country driving—Gulf test cars showed these results:

- Higher-than-new horsepower!
- Better-than-new on gasoline mileage!
- And not a single trace of carbon knock or pre-ignition at any time—even on the steepest mountain grades!

COMPLETELY NEW! SUPER-REFINED

New Gulf No-Nox

THE HIGH-EFFICIENCY GASOLINE

General view of Engineering Department

Alliance anticipates tomorrow's increased production demands

Engineering, South End

Research Engineering

Engineering, North End

The Alliance Engineering Department is organized to assist industry in solving its material handling problems. Many of the safety and mechanical features now accepted as standard practice on steel mill cranes had their inception in the Engineering Department of The Alliance Machine Company.

Alliance cranes lift and position the smallest loads up to and including 450-ton ladles of molten metal and 600-ton battleship turrets. From Pittsburgh, Pennsylvania, to Jamshedpur, India, Alliance cranes are handling the world's heaviest loads.

When you are considering tomorrow's expansion program, The Alliance Machine Company's Engineering Department is always ready to render any assistance necessary. Our more than half a century in the field of material handling qualifies us to solve your problems.

World's Largest Builder of the World's Largest Cranes

THE *Alliance* MACHINE COMPANY

Main Office: Alliance, Ohio — *Founded 1901*

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION • COKE PUSHERS

Give Us The Runway And We'll Lift The World

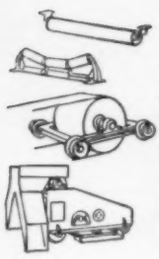
Carry the load via Link-Belt belt conveyors... SEE YOUR COSTS GO DOWN

LINK-BELT offers you the "total engineering" so necessary for top efficiency

DESIGNED FOR OVERALL EFFICIENCY

Because of its unrivalled experience, Link-Belt can do a better job of gathering and analyzing all data. Proposals reflect this understanding of the most practical way to fit conveyors into your overall system requirements.

BUILT FOR LONG-LIFE PERFORMANCE



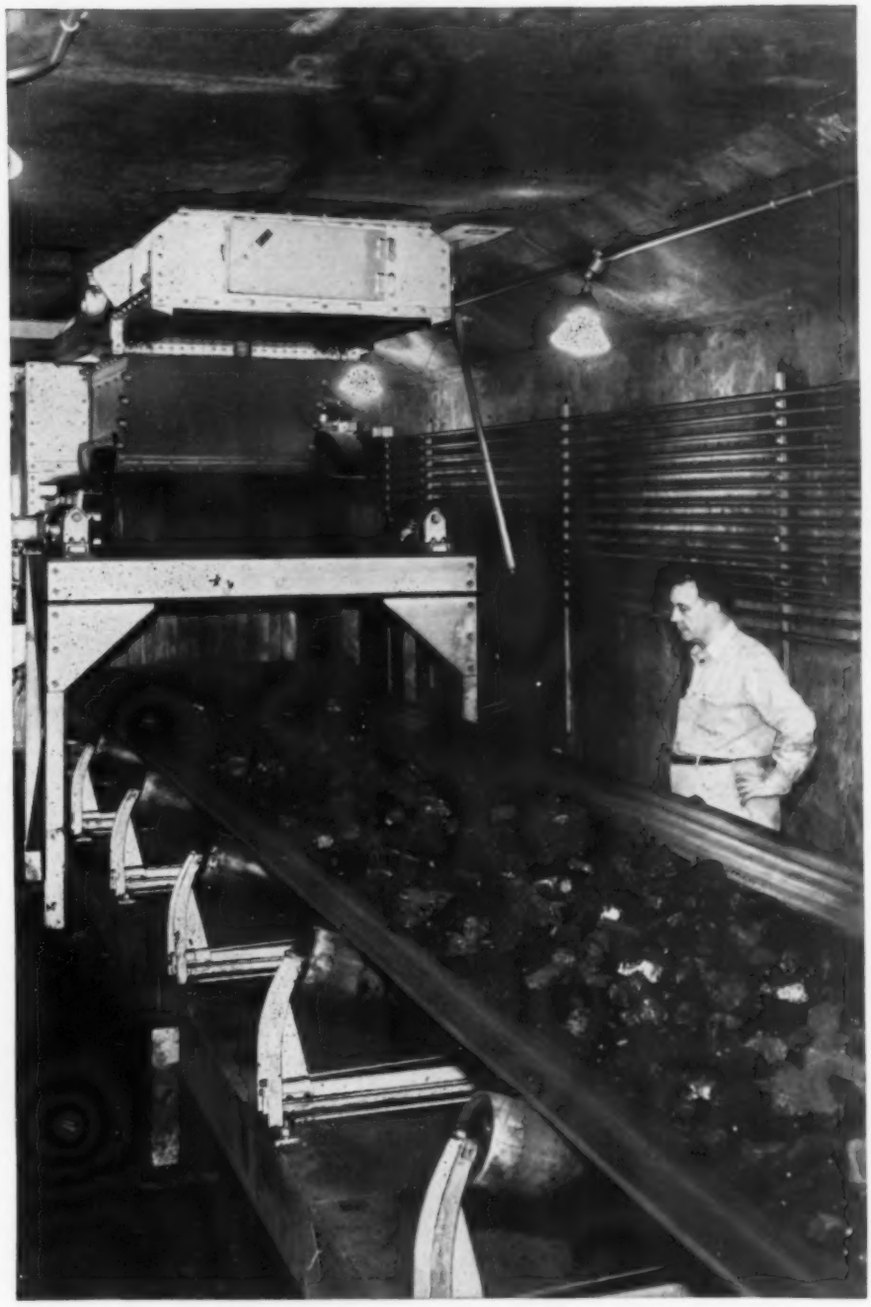
Link-Belt manufactures all components and related feeders and conveyors. You are assured of the right equipment because of this breadth of line. And Link-Belt will supply the highest grade belts engineered to the job.

DELIVERS FULL RATED CAPACITY

Link-Belt follows through on every detail of the job, including electrical controls and even wiring and foundations. What's more, Link-Belt will furnish experienced erection superintendents, staffs and skilled crews if desired.

ASSURE SATISFACTORY PERFORMANCE

When you rely on Link-Belt as a single source for your complete system, Link-Belt accepts responsibility for placing it in full operating readiness. We will also supervise modernization of existing systems.



Link-Belt 60-in. wide belt conveyor served by eight L-B 48-in. wide belt feeders, in reclaim tunnel under coal dock.

WHETHER it's a single belt conveyor or a complete system, there's no substitute for Link-Belt equipment and Link-Belt engineering. Call the district sales office near you for all the facts on this unique single-contract service.

LINK-BELT

BELT CONVEYOR EQUIPMENT

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

13.467

"Taylored"
TO MEET YOUR FURNACE REQUIREMENTS . . .

Base: Sintered synthetic mullite
P.C.E.: Cone 39 (3389°F.)
Al_2O_3 Content: 67-69%
Available as: Brick, special shapes

Base: Highest quality, premium grade Indian kyanite
P.C.E.: Cone 37-38 (3308-3335°F.)
Al_2O_3 Content: 57-60%
Available as: Brick, special shapes, specialties

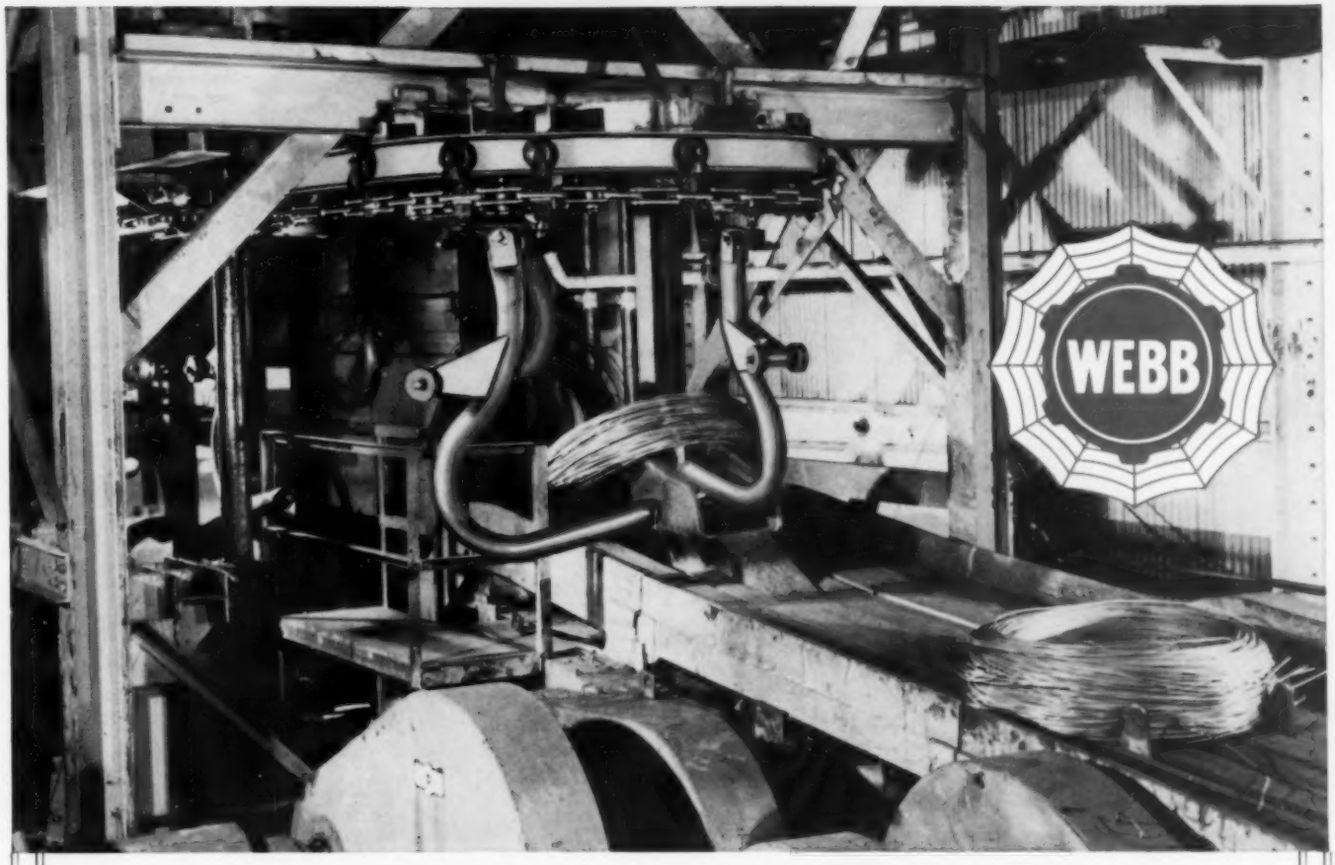
Base: Highest quality, premium grade Indian kyanite fortified with alumina
P.C.E.: Cone 38-39 (3335-3389°F.)
Al_2O_3 Content: 66-68%
Available as: Brick, special shapes

Base: Sintered Corundum
P.C.E.: Cone 41 (3578°F.)
Al_2O_3 Content: 88-90%
Available as: Brick, special shapes, specialties

Base: Purest commercial grade zirconium silicate
P.C.E.: Above Cone 42 (above 3659°F.)
Available as: Brick, special shapes, specialties

Additional data on these brands with recommendations on applications will be gladly supplied on request. Contact your Taylor field engineer or write us direct.

The **CHAS. TAYLOR SONS Co.**
A SUBSIDIARY OF NATIONAL LEAD COMPANY
REG. U. S. PAT. OFF.
REFRACTORIES SINCE 1864 • CINCINNATI • OHIO • U. S. A.



Jones & Laughlin Hot Rod-Coils Handled *Automatically* By Webb Conveyors

Hot from the laying or pouring reels, these coils of rod steel are handled automatically by Webb Conveyors throughout their trip to storage or shipping in the Jones & Laughlin Rod Mill at Aliquippa, Pa.

Rod coils are approximately 46" in diameter and weigh 600 pounds—4 of these hot coils are handled by Webb Conveyors every minute without a hand touching them. Single and double-strand drag conveyors and overhead trolley conveyors are employed in this highly integrated materials handling system.

Typical of the smooth automation and ingenious transfer of coils from one conveyor to another is the illustrated lifting of coils by a cam actuated bobber at the end of the drag conveyor, and automatic insertion of trolley conveyor hook into rod coils. This operation is accomplished without distortion of coils, and in spite of loose rod ends.

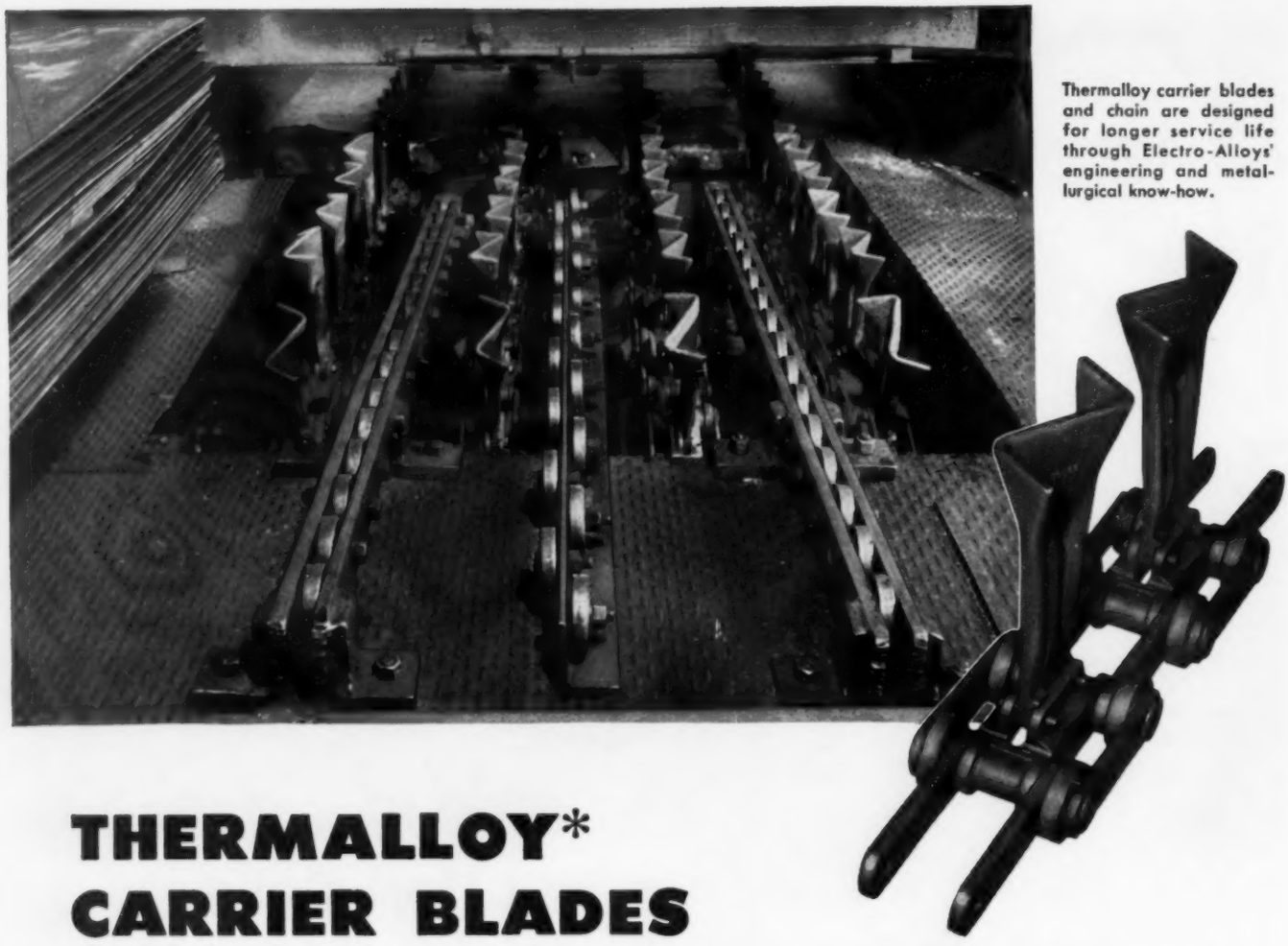
Ask a Webb engineer to look at your tough handling problems—his experience and engineering knowledge are waiting your call.

Additional Webb Services—Through its subsidiaries, Control Engineering and Webb Forging Co., the Jervis B. Webb Co. designs and manufactures electronic and electrical controls for conveyors, machine tools, etc. Also quality drop forgings.

JERVIS B. WEBB CO.
Conveyor Engineers and Manufacturers
8941 ALPINE AVENUE • DETROIT 4, MICHIGAN

Send for fully illustrated catalog that provides complete information on Webb conveyors

FACTORIES: DETROIT · LOS ANGELES · HAMILTON, ONTARIO
OFFICES AND REPRESENTATIVES THROUGHOUT THE WORLD



Thermalloy carrier blades and chain are designed for longer service life through Electro-Alloys' engineering and metallurgical know-how.

THERMALLOY* CARRIER BLADES

. . . last 7 times longer than previous design!

Here's how Electro-Alloys' metallurgical and engineering know-how made a difference in the life of carrier blades used in a large steel plant.

In this plant, stainless and silicon steel sheets are heated in a 40-foot furnace where temperatures range from 1500°F. to 2200°F., depending on the type of steel. Carrier blades and chain entering the furnace are subjected to this high heat, and then, sudden cooling to 600°F. occurs as they return under the furnace to renew the heating cycle. Old style carrier blades lasted only three weeks.

Electro-Alloys engineers observed two weaknesses in the previous design. Blade supports tended to bend . . . and carrier tips broke. By redesigning the flat, vertical supports to corrugated shapes, Electro-Alloys eliminated bending. By using a "Z" shape top, which had previously proved successful at another mill, broken carrier tips were eliminated. In its modern foundry, Electro-Alloys cast carrier blades and chain in grades of Thermalloy best suited for this operation. Results were excellent . . . *Thermalloy carrier blades now last nearly seven times as long as the old design.*

It pays to apply the experience of Electro-Alloys . . . and get longer service life from heat-resistant alloy parts by using Thermalloy. To put such knowledge to work for you, just call your nearest Electro-Alloys office, or write Electro-Alloys Division, 5006 Taylor Street, Elyria, Ohio.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION

Elyria, Ohio

*Reg. U. S. Pat. Off.

This way you have better temperature control . . . and you save on fuel and maintenance

Cover lifter built by Lake Erie makes a big improvement in The TIMKEN Company's soaking pit operation

The soaking pit cover lifter illustrated is a new design built for The Timken Roller Bearing Company by the Lake Erie Engineering Corporation. It has many points of superiority over most other types of cover lifters. Obviously, it is a tremendous improvement over old-style covers that damage brickwork and do not provide a good seal because they have to be dragged across the top of the pit to open and close it.

The Timken Company is just one of the many nationally-known customers for LAKE ERIE'S specialized equipment and services. These companies — and industrial firms all over the world — have learned the advantages of doing business with LAKE ERIE which has one of the most competent engineering staffs and completely equipped plants in the heavy machinery field. Ask us to quote on your next requirements. LAKE ERIE'S Rolling Mill Auxiliary Equipment and Rebuild Services — famous in both ferrous and non-ferrous mills in Western New York for years — are now available throughout the United States.

Send for Bulletin 50.1

LAKE ERIE
ENGINEERING CORP.
BUFFALO, N.Y. U.S.A.

LAKE ERIE ENGINEERING CORP.
570 Woodward Avenue, Buffalo 17, N. Y.
HYDRAULIC PRESSES • DIE CASTING MACHINES
ROLLING MILL AUXILIARY EQUIPMENT

ROLLING MILL AUXILIARY EQUIPMENT
DESIGNED AND MANUFACTURED BY LAKE ERIE

INDIVIDUAL UNITS

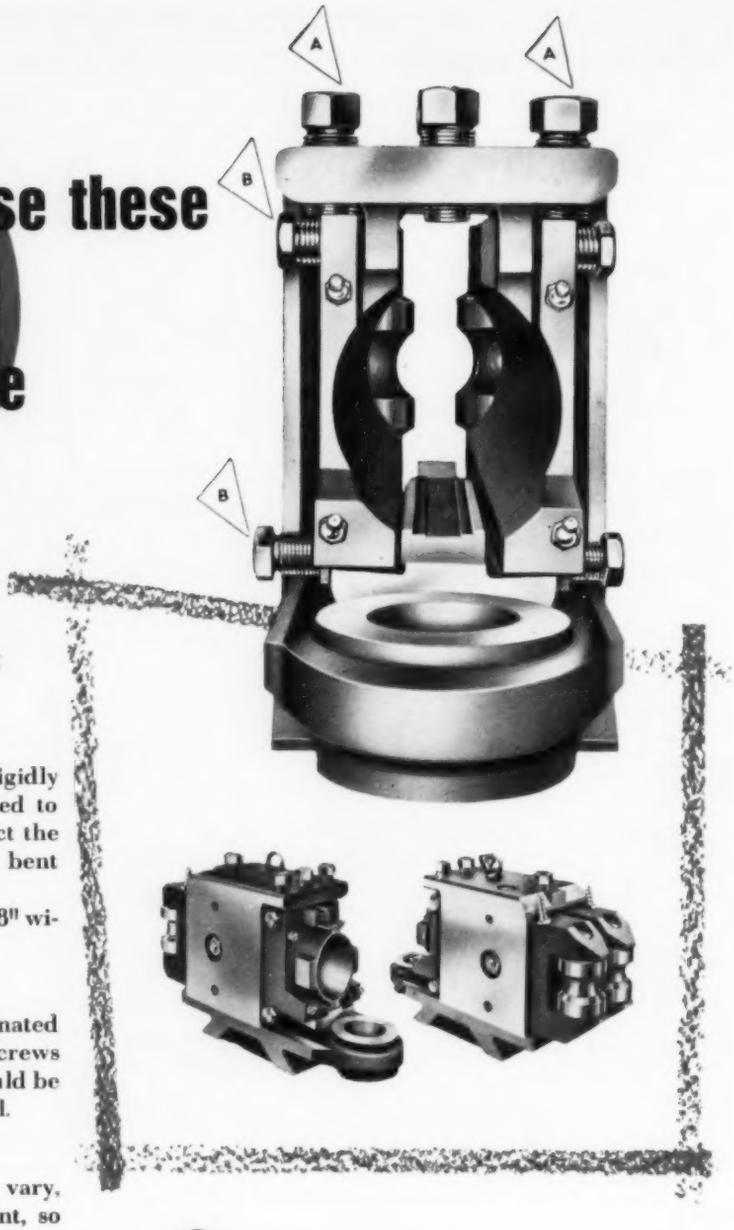
Mill tables and conveyors • Coilers and uncoilers
Shears, up-cut and down-cut • Pay off and take up reels • Stretcher levelers
Wet and dry scrubbers • Scrap ballers and balers • Turn tables
Dancer roll units • Belt wrappers • Slitters and side trimmers
Roller levelers • Pilers and unpilers • Coil ramps and coil boxes
Oiling machines • Dryers • Upenders and downenders
Tension bridles • Shear gauges • Peelers and processors

COMPLETE LINES

Coil build up lines • Sheet pickle lines • Sheet and strip shearing lines
Cleaning lines • Strip pickle lines • Resquare lines
Slitting lines • Annealing lines

PLUS REBUILD SERVICES LAKE ERIE®

8 good reasons why you should use these ROLLER GUIDES in your bar or wire rod mill



The Morgårdshammar Roller Guides — patented in most countries of industrial importance — are constructed according to the following principles:

1 The entry friction guides are rigidly clamped into the guide box. They are intended to lead the oval to the groove in the roller, to protect the rollers against overloading, and to straighten bent rods.
The groove in the entry guides is made about 1/8" wider than the oval.

2 The rollers are mounted on laminated springs, which can be adjusted by means of the screws "B", and hold the oval steadily even if there should be some slight variation in the thickness of the oval.

3 If the thickness of the oval should vary, the springs of both rollers yield an equal amount, so that the oval remains in the centre of the groove.

4 To tilt the oval, the screws "A" are adjusted as shown by the arrows. One roller will then be lifted as much as the other is lowered.

5 As the oval is held very rigidly, the leader oval for wire rod may be thick, unless other circumstances call for a thinner oval.

6 The roller guide assemblies are narrow, and all screws that require adjustement during rolling are accessible from the front of the mill. No lateral space outside the guide box is therefore required for gaining access to the set screws, and the guide box assembly can thus be located close to the mill housing.

7 As the groove in the entry guides is wide and nothing but rolling friction acts on the oval, the latter is very easily introduced into the pass, and there is practically no risk of scratching the bar.

8 The roller guide may be used not only for leader and drawing oval passes but also for edging flats as well as for rolling squares, hexagons, octagons and various other sections, for instance in reduction passes for hexagon. It is suitable for all types of rolling mill. An important advantage is that the roller guide enables repeaters to be used in rolling thick leader-ovals.

P.S. Practically speaking, every bar and wire rod mill in Scandinavia uses roller guides of our design.

MORGÅRDSHAMMAR

MORGÅRDSHAMMARS MEK VERKSTADS AB • MORGÅRDSHAMMAR • SWEDEN

Telegrams: Morgårdshammar, Ludvika

For the complete story — send for your copy of bulletin L3—1E.

How to whip up a wind storm WITHOUT DUST!

Above: Dual installations of Multi-Duty filters, located in housing at entrance of each of three air intakes, prevent dust damage to turbo-blowers.

Right: Interior view showing the three giant turbo-blowers whose diet of dust-free air is assured by Multi-Duty filters.

Multi-Duty Filters Insure Clean Intake Air For Trio of Giant Turbo-Blowers

THE three massive turbo-blowers shown in inset supply the combustion air for the blast furnace operations at this large Eastern steel mill. The air they swallow must be free of dust or these minute abrasive particles will quickly wear their impeller blades—and that means "down time" that's measured not in cost of repairs but in dollars of vital steel production lost.

Here, as in scores of other steel mills, AAF Multi-Duty was assigned the all-important air cleaning job. This automatic, self-cleaning filter is designed for constant efficiency and uniform air cleaning regardless of the dust load. It works every shift without supervision — requires no attention other than periodic inspection and removal of sludge at regular intervals.

For complete information on the Multi-Duty and its "work record" in the steel industry, just call your local AAF representative or write direct for Bulletin 241.

AAF

herman nelson

American Air Filter
COMPANY, INC.

American Air Filter of Canada, Ltd., Montreal, P. Q. • 302 Central Avenue, Louisville 8, Kentucky

WELL, WHAT DO YOU KNOW....

DRY!

Unusual, perhaps, but not impossible. The use of hydraulic power... and particularly high pressure hydraulic power . . . does NOT have to mean a WET installation ... not if the system is properly engineered. Similarly, it does not have to mean FREQUENT CHANGES and CONTINUOUS MAINTENANCE . . . not if the components are correctly designed and built for the particular requirements.

Indeed, hydraulics can afford a very efficient and flexible source of power. We would be pleased to discuss this further with you and to show you the many advantages of LASSMAN engineered systems and quality hydraulic equipment for trouble free, continuous service.

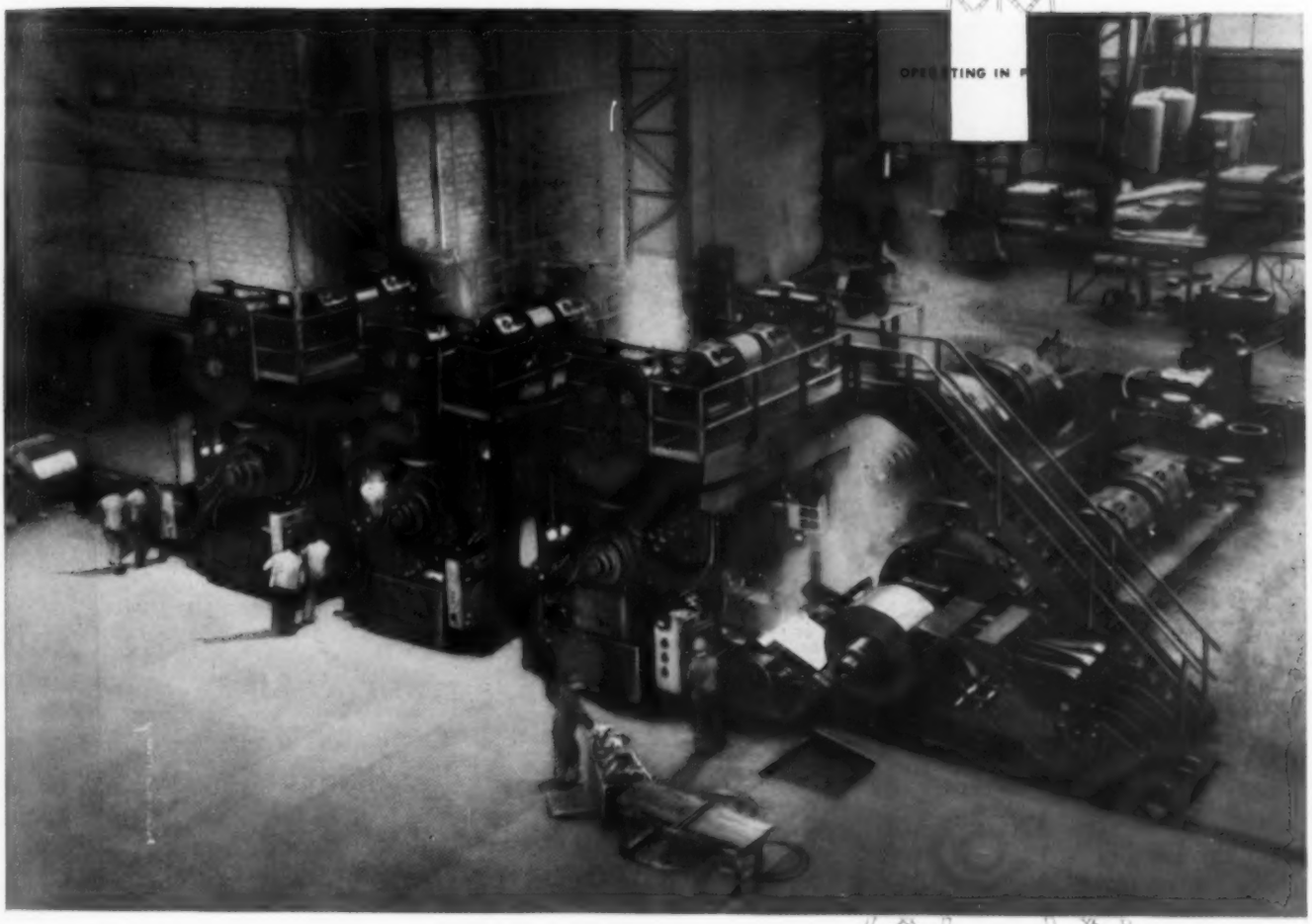
Quality EQUIPMENT for *Quality* PERFORMANCE

BENJAMIN LASSMAN & SON Route 8, GLENSHAW, PA.

UNITED

®

4-HIGH 3-STAND TANDEM COLD MILL



UNITED

ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

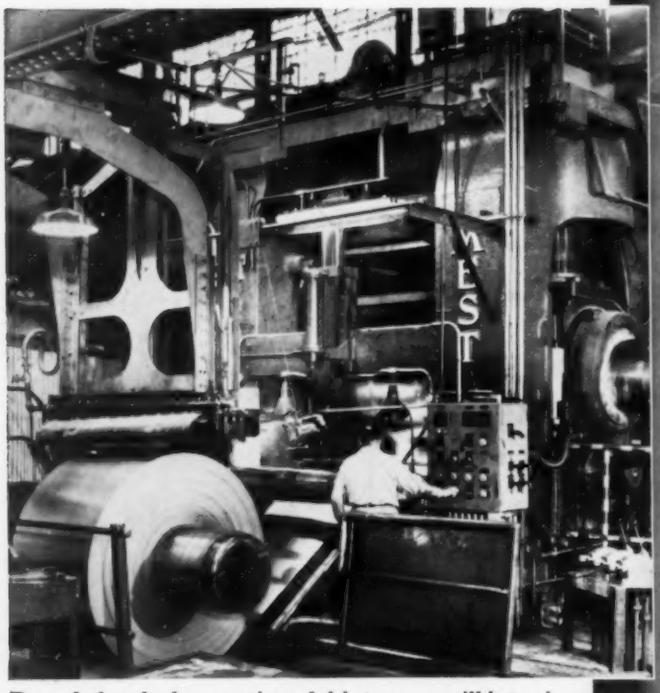
Plants at: PITTSBURGH • VANDERGRIFT • NEW CASTLE • YOUNGSTOWN • CANTON

Subsidiaries: ADAMSON UNITED COMPANY, AKRON, OHIO
LOBDELL UNITED COMPANY, WILMINGTON, DELAWARE
STEDMAN FOUNDRY AND MACHINE CO., INC., AURORA, INDIANA

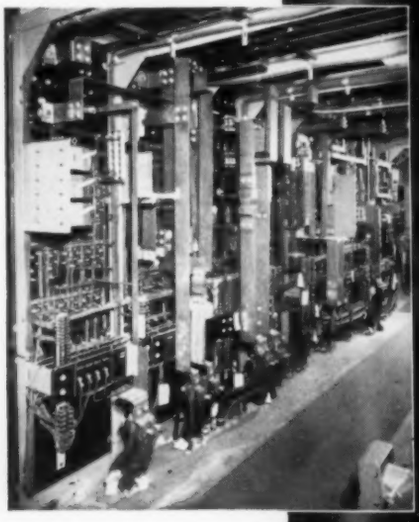
Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other Heavy Machinery
Manufacturers of Iron, Nodular Iron and Steel Castings, and Weldments

UNITED CAN SERVE YOU...
NO MATTER WHERE IN THE WORLD YOU ARE.

160 PRODUCTION HOURS PER WEEK MAKE OKOLITE-OKOPRENE A MUST FOR THIS MILL



Round-the-clock operation of this temper mill is typical of the severe conditions that have proved Okolite-Okoprene's dependability in industrial service.



This interior view of the motor room shows the control panels for the temper mill, wired for dependability with Okolite-Okoprene.

Operating schedules on the 77-inch Temper Mill at Jones & Laughlin's Cleveland plant call for 20 turns a week of eight hours each—160 hours per week—and the schedule is kept. As in so many other steel plant installations where loss of production due to equipment failure is a serious factor, Jones & Laughlin here relies on Okolite-Okoprene to eliminate electrical outages.

Millions of feet of Okolite-Okoprene installed in every service under every operating condition prove the toughness and dependability of Okolite-Okoprene wires and cables. Steel mill applications, where heat, moisture, oil and abrasion destroy ordinary cables, are the best testimonial to the high quality of Okolite-Okoprene. The Okoprene sheath—Okonite's neoprene compound—will not rot or deteriorate under the most difficult operating conditions. Okolite insulation, proved in use for 30 years, provides excellent ozone, moisture and heat resistance, high dielectric strength and long life.

Bulletin IS-1053 contains full information on the applications and advantages of Okolite-Okoprene. Write for it today to The Okonite Company, Passaic, N. J.

OKONITE insulated cables

SINCE 1878

brightening the future of a roll...*quickly*

The machine is a Farrel heavy-duty roll grinder. It will take heavy cuts for rough grinding or grind a roll to the highest mirror finish. On either type of work there's no faster way to grind a roll.

Rolls ground on this machine have longer life. The exceptional smoothness and absence of vibration in roll, wheel and traverse drives means less metal has to come off to clean up a roll in roughing and finishing operations.

This grinding accuracy is a vital factor in reducing the frequency of roll replacement, and consequently the cost of new rolls. Furthermore, faster grinding means increased productive capacity of the machine, and adds up to savings in labor cost.

If you would like to cut down on grinding time and cost, and refinish your rolls more accurately, look into Farrel grinders. They are available in two types—type HD shown here, and type TT with traveling work table. Bulletins giving complete specifications of either type are yours for the asking.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.

Sales Offices: Ansonia, Buffalo, New York, Akron, Chicago, Los Angeles, Houston FB-961

Farrel-Birmingham®

WHY STEEL PRODUCTION COSTS GO DOWN WITH

1. **As the world's highest quality ramming mix for open hearth bottoms, Permanente 165 *lasts far longer* than other materials.**
2. **During this longer life, a Permanente 165 *Periclase* bottom requires *far fewer repairs*—thus drastically reduces down-time and repair material used!**
3. **As a result, you get more steel tonnage per month with Permanente 165—*and at lower bottom cost!***

Let your Kaiser refractory engineer provide *you* with research, design and installation service to help you obtain more tonnage, improved quality—and lower operating costs!

Call or write *Kaiser Chemicals Division,* Kaiser Aluminum & Chemical Sales, Inc. Regional sales offices: OAKLAND 12, California, 1924 Broadway; AKRON 8, Ohio, First National Tower Bldg.; CHICAGO, 518 Calumet Bldg., 5231 Hohman Ave., Hammond, Indiana.

Kaiser Chemicals

Pioneers in Modern Basic Refractories

Basic Refractory Brick and Ramming Materials • Dolomite Alumina • Magnesia • Magnesite • Periclase

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Patent Reviews

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington, D. C., at 25 cents each . . . patents reviewed cover period June 15, 1954 through July 6, 1954 . . . .

PRODUCTION OF STEEL DIRECTLY FROM ORE

▲ According to Eugenio Lubatti, in U.S. 2,681,275, issued June 15, 1954, a very pure steel can be produced directly from iron ore by a process based on the following steps, and illustrated schematically in Figure 1:

a. A process-starting slag, similar to slag from blast furnaces, is prepared, either directly in the furnace or in a separate container, for example by melting a mixture of lime, silica and alumina conveniently dosed.

b. Iron ores (or industrial residues containing iron), reducing agents (in particular coal), slag builders (for example lime) in addition if required, and other minerals for instance manganese, are if necessary broken up to powder or small pieces.

c. The powdered materials under (b) are intimately mingled together.

d. The materials are poured on a bed of molten slag prepared in a furnace (see phase a) and maintained at a high temperature, so as to build a layer of nearly uniform thickness. Care should be taken that the charge completely covers the surface of the molten bath, in particular that it comes in contact with the walls and is not excessively crammed together in order not to obstruct the passage of the gases; nor should the charge on the other hand be so loose as to build escape passages for the gases to escape without having reacted.

e. The slag is heated to and maintained at a high temperature by the passage of electric current. The heat of the slag is transferred to the overlying charge whose components react, the minerals are reduced, the lime stone is transformed into calcium oxide and dissolves the gangue; the result is droplets of metal and droplets of slag which arrive by gravity at the molten bath, the former separating out by difference of specific gravity and settling to the bottom, the latter diffusing and incorporating with the bath.

f. The metal gradually forming is drawn from the bottom of the furnace either continuously or intermittently as it is formed.

g. Slag is drawn in a continuous or intermittent manner through an opening made in the furnace wall, so as to maintain approximately constant the thickness of the slag layer in the interior of the furnace.

h. The feeding of the furnace from above is continued.

i. The metal drawn from the furnace may be left to solidify and then charged in a steel furnace. However, it is preferable, for obtaining a larger production and saving heat, to introduce the molten metal, drawn from the reduction furnace, directly into a steel furnace, where the refining process is carried out. Although the refining is conducted on the same general lines as the production of steel from cast iron, ore, and scrap-iron, it proves to be very rapid since the material charged into the furnace has a composition very near the final one.

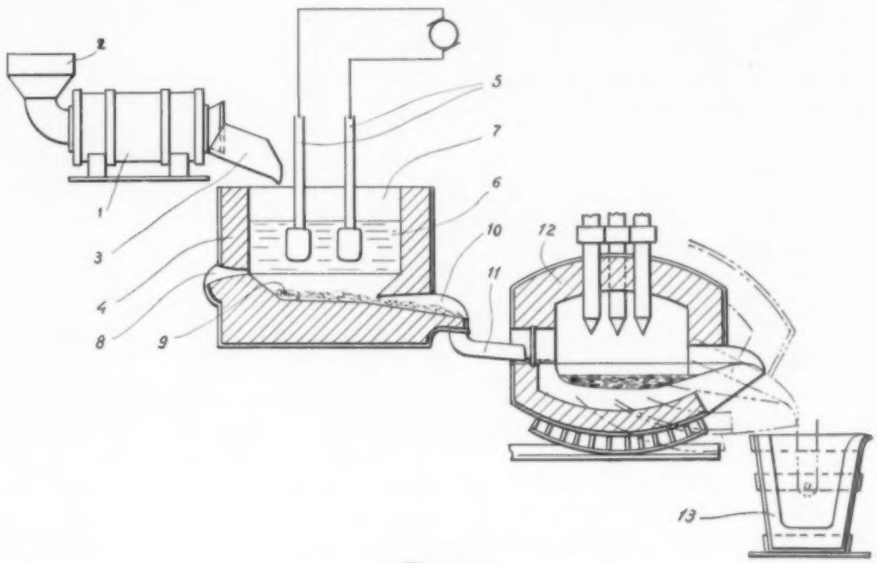


Figure 1

j. If it is desired to obtain special steels, the required corrective will be added while the material is in the refining furnace.

In Figure 1, a mixer 1 receives the materials from a hopper 2 and discharges them through a channel or funnel 3 which leads to a reduction furnace 4 where the electrodes 5 heat a bath 6 on the surface of which a layer of charge 7 is disposed.

The slag can be drawn off through the spout 8, while the metal depositing at 9 is drawn through the opening 10 and taken along the channel 11 to

the steel furnace 12 which, when caused to tilt at the right time (as shown in dot and dash lines), pours the metal into the ladle 13.

One example of application of the process:

To put the furnace into operation, a mixture is melted which consists of 44 per cent calcium oxide, 37 per cent silica, 12 per cent alumina, the remainder being various impurities.

A slag is obtained of approximately the following percentage composition: 43.7 CaO, 2.98 MgO, 36.5 SiO_2, 11.5 Al_2O_3.

As homogeneous a mixture as possible, composed of the following products, is charged:

1. 1700 Kg iron ore with the following per cent composition (referred to the weight of the dry product); 59.5 Fe, 10 SiO_2, 3 Al_2O_3, 0.7 Mn, S + P + other impurities 1.

2. 300 Kg coke in pieces of size from 0 to 10 mm (fine powder), having the following percentage composition referred to as dry product: 80 fixed carbon, 8 silica, 3 Al_2O_3, 2 MgO, 6 volatile substances, S + P 1.

3. 460 Kg limestone having the percentage composition: 51 CaO, 40 Co_2, 1.5 Al_2O_3, 3 SiO_2, 2.5 MgO.

From the furnace, a gas flows out containing 540 kg carbon dioxide (of which 400 originated from the reduction and 140 from decomposition of the limestone, and 270 kg of carbon monoxide; it also contains various impurities and small quantities of water vapor.

The temperature of the gases at the outlet is only a little above room temperature.

From the reduction furnace, a ton of raw steel is obtained which has the following percentage composition: 97.2 iron, 1.5 carbon, 0.7 manganese, 0.5 silicon, sulphur + phosphorus less than 0.1 in total.

The metal leaves the furnace at a temperature of about 1400 C and the slag at about 1550 C.

In the case of the metal being ladled to the refining furnace, it should be drawn off at a somewhat higher temperature to compensate for cooling during transit.

The slag which is discharged has the following approximate percentage composition: 43.7 CaO, 2.28 MgO, 36.5 SiO_2, 11.50 Al_2O_3, 2.62 FeO, 1.75 MnO and 0.87 sulphur.

The iron oxide content of the slag is remarkably low, which indicates a good utilization of the iron content of the starting material. For every ton of steel, about 570 kg of slag are produced.

Refining in a furnace of the reverberatory type, by the addition of selected scrap or ore, will require a very short time due to the purity of the molten bath and the comparatively low carbon content.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,680,938	6/15/54	Apparatus for removing scale from metal sheets	The Osborn Manufacturing Co.
2,680,976 and 2,680,978	6/15/54	Production of sheet and strip material	The British Iron & Steel Research Assoc.
2,680,977	6/15/54	Cross-over device for rod mill repeaters	United States Steel Corp.
2,681,069	6/15/54	Apparatus for cleaning rolling mills	United States Steel Corp.
2,681,158	6/15/54	Apparatus for cooling sinter	Kaiser Steel Corp.
2,681,485	6/22/54	Centrifugal casting of metal	Electric Steel Foundry Co.
2,681,573	6/22/54	Pyrometer for heated gas temperature measurement	William B. Brown
2,681,642	6/22/54	Water-cooled furnace door for open hearth furnaces	Levi S. Longenecker
2,681,874	6/22/54	Heat treating and preferentially hardening surfaces of steel articles	Robert J. Linney
2,681,971	6/22/54	Electric furnace control	The Ohio Crankshaft Co.
2,682,301	6/29/54	Liquid fuel burner for open hearth furnaces	United States Steel Corp.
2,682,433	6/29/54	Crosshead assembly	United States Steel Corp.
2,682,566	6/29/54	Radiation melting furnace	Iggesunds Bruks Aktiebolaget
2,683,032	7/ 6/54	Basic lined cupola	Meehanite Metal Corp.
2,683,077	7/ 6/54	Roasting sulfide ores of iron	Standard Oil Development Co.
2,683,086	7/ 6/54	Low alloy steel containing boron and titanium for high-temperature use	The Timken Roller Bearing Co.

PROCESS FOR CHLORINATING IRON ORES

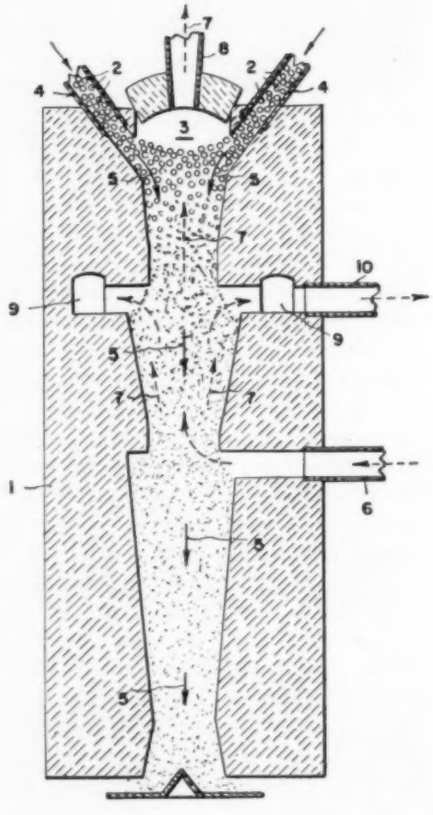
On U.S. 2,681,855, issued June 22, 1954 to T. F. Holmberg and assigned to Osakeyhtio Vuoksenniska Aktiebolag, a process for purifying iron ores by chlorination is disclosed.

The mixture of ores and a chlorinating salt is bullet molded preferably to balls with a diameter about 25 mm and preheated in a separate furnace at a temperature of 200–300 C, and a sufficient amount of gas is blown through the furnace so that the surplus of water as well as water of crystallization is removed. Then the lumps are introduced into the reducing atmosphere furnace.

The bullet molded lumps endure the high temperature in the reaction furnace and will maintain their lump form without flowing into one another during the chlorination.

The heating gas, which is introduced at the lower part of the reaction furnace at a temperature of about 1100–1300 C, is partially withdrawn from the furnace before it reaches the top of the furnace, i.e. before it becomes cooled down to the exit temperature of 200–500 C. Preferably 25 per cent of the gas is removed when its temperature has reached 700–800 C. At this temperature, the gas contains a high percentage of metal chlorides, and by removing it

Figure 2



FOR BRONZE PARTS

a choice of 5 casting methods to increase design flexibility . . . and lower metal and machining costs

There's one best way to cast a part. National Bearing is *equipped* to use the method that will provide a sound casting and allow you greatest savings in metal weight and a minimum of machining.

If desired, NBD will do all required machining—rough or finished—and deliver parts ready to use.

Delivery is fast because there are six strategically located National Bearing plants. Reduced transportation costs provide added savings.

Begin now to profit by NBD's 80 years of casting experience. Send us your prints. Our bids are based on the most suitable casting method. Orders will be filled promptly.

Write for the new folder *Copper and Bronze Castings and Bearings for Blast Furnaces.*

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION

4930 Manchester Avenue, St. Louis 10, Mo.

***Plants in:* St. Louis, Mo. Meadville, Pa. Niles, Ohio Portsmouth, Va. St. Paul Minn. Chicago, Ill.**

cuts hot steel slabs up to 7" thick by 42" wide

With a maximum knife pressure of 2,200,000 pounds and a combined stroke of 13 inches, this new Lewis up-and-down cut Shear has the capacity to cut hot steel slabs up to 7 inches x 42 inches. The knives are made of special shear knife steel . . . hardened and ground to withstand the terrific pressure. At continuous running speed, driven by a 250 hp motor, this big slab shear can make twelve cuts per minute.

At any time convenient to you, we'll be glad to give you more information on the design and specifications of our Lewis Slab Shear. And, of course, our experienced engineers and modern manufacturing facilities are always available to help you with any problem involving rolling mill machinery.

new LEWIS up-and-down cut SLAB SHEAR

BLAW-KNOX COMPANY • LEWIS MACHINERY DIVISION
PITTSBURGH 22, PENNSYLVANIA

BLAW-KNOX

LEWIS PRODUCTS: Two-High Mills • Three-High Mills • Four-High Mills • Bar, Billet and Structural Mills
Rod Mills • Coilers • Tables • Shears • Levelers • Pinion Stands • Gear Drives • Roll Lathes • Flaking Mills

before the gas is cooled down to condensation temperature, the risk of condensation of the chlorides in the cold part of the furnace is counteracted.

The process is shown schematically in Figure 2. The reaction furnace is a shaft furnace 1. The mixture of ore and chlorinating agent is introduced in bullet molded lumps 2 at the top 3 of the furnace through inlets 4, and moves during the chlorinating process towards the bottom of the furnace, as shown by the arrows 5.

A heating gas is introduced at 6 into the furnace at a temperature of 1100–1300 C. This gas ascends in the furnace against the movement of the ore, as shown by the arrows 7, and is removed from the top of the furnace at the point 8 at a temperature of 200–500 C.

At 9 a part of the gas, preferably 25 per cent, is removed through the channels 10 at a temperature of 700–800 C. The rest of the gas continues towards the top of the furnace.

SMELTING HYDROGEN-REDUCIBLE ORES

Molten iron or steel can be produced directly from iron ore in a process described by Karl Kautz in U.S. 2,681,854, issued June 22, 1954.

Hydrogen-rich fuel gas is incompletely burned with oxygen in a pressure melting furnace, to produce a non-oxidizing atmosphere at melting temperature. The gases are cooled in two stages, first by endothermic reactions to about 2400 F, and second by dilution with reducing gases to produce a reducing gas mixture without free carbon at 1500-1800 F. This gas mixture is then passed through a column of lumps of hydrogen-reducible iron ore. The reduced ore is then passed directly into the melting furnace while maintaining the ore at about 1500–1800 F.

It is claimed that hot sponge iron of very high purity with very little carbon can be produced in the contacting tower. If it is desired to produce steel in the melting furnace, the carbon may be added by the direct production of carbon black in the melting furnace. This can be accomplished by cooling the gases by adding additional hydrocarbon-containing fuel. Another way of increasing the carbon content of the melt is by introducing carburizing material to the feed screw which moves the reduced ore into the melting furnace.

The inventor claims his process is economical, because part of the combustible partially-spent gases are used for roasting and preheating the ore and limestone, and the remaining partially-spent gases can be used for fuel in a hydrogen-generating furnace or in a boiler.

The process and apparatus are described in considerable detail in the patent. A general view of the apparatus is shown in Figure 3. The melting furnace is shown at 10, and the tower or shaft kiln at 11. The helical screw 61 charges material from the bottom of the tower to the melting furnace. Solid materials are charged at the top 11 of the tower and travel downward. Air is admitted through the upper tuyeres 68 ft to burn part of the partially spent gases, thereby calcining the limestone lumps. The reducing gases from the melting furnace are admitted near the bottom of the tower through tuyeres 67.

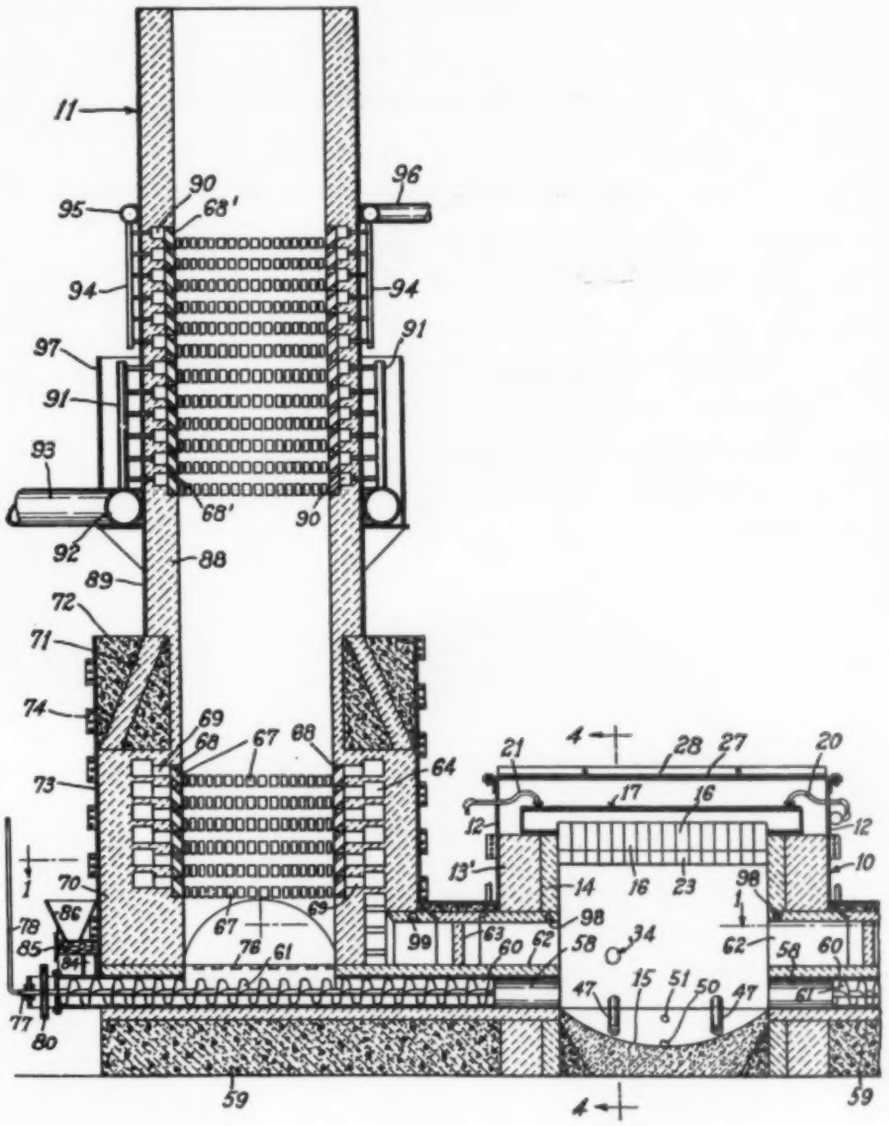


Figure 3

SLAG DETECTION IN STEEL SHEETS OR PLATES

After steel has been rolled into sheets or plates, it is customary to shear off one section after another until manual inspection indicates substantial freedom from slag.

In U.S. 2,680,900, patented by Garrett B. Linderman and Dorothy B. Earle on June 15, 1954, a compound of a radio isotope miscible with the slag but immiscible with the metal is introduced into the molten metal. The slag is located after rolling, by detecting the radioactivity. Suitable compounds are the chlorides of Barium 140 and Barium 131.

A lot of Ideas

about making seamless tubing

have been worked out

between the STEEL INDUSTRY

and AETNA-STANDARD

in 53 years of association

SUBSIDIARY and ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England — Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.

Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.

M. Castellvi, Inc., New York, N. Y. — Mexico, Central and South America.

Societe de Constructions de Montbard, Paris, France — France, Belgium, Holland, Luxembourg, Switzerland.

Demag Aktiengesellschaft, Duisburg, Germany — Germany, Austria, Yugoslavia, Greece, Turkey, Egypt.

Compagnia Italiana Forme Acciaio, Milano, Italy — Italy.

Aetna-Japan Company, Ltd., Tokyo, Japan — Japan.

Hale & Kullgren, Inc., Akron, Ohio — Representative for the Rubber Industry.

Standard Engineering Company, Ellwood City, Pa.

Trans-World Traders, Pittsburgh, Pa.

Designers and Builders to the Ferrous,

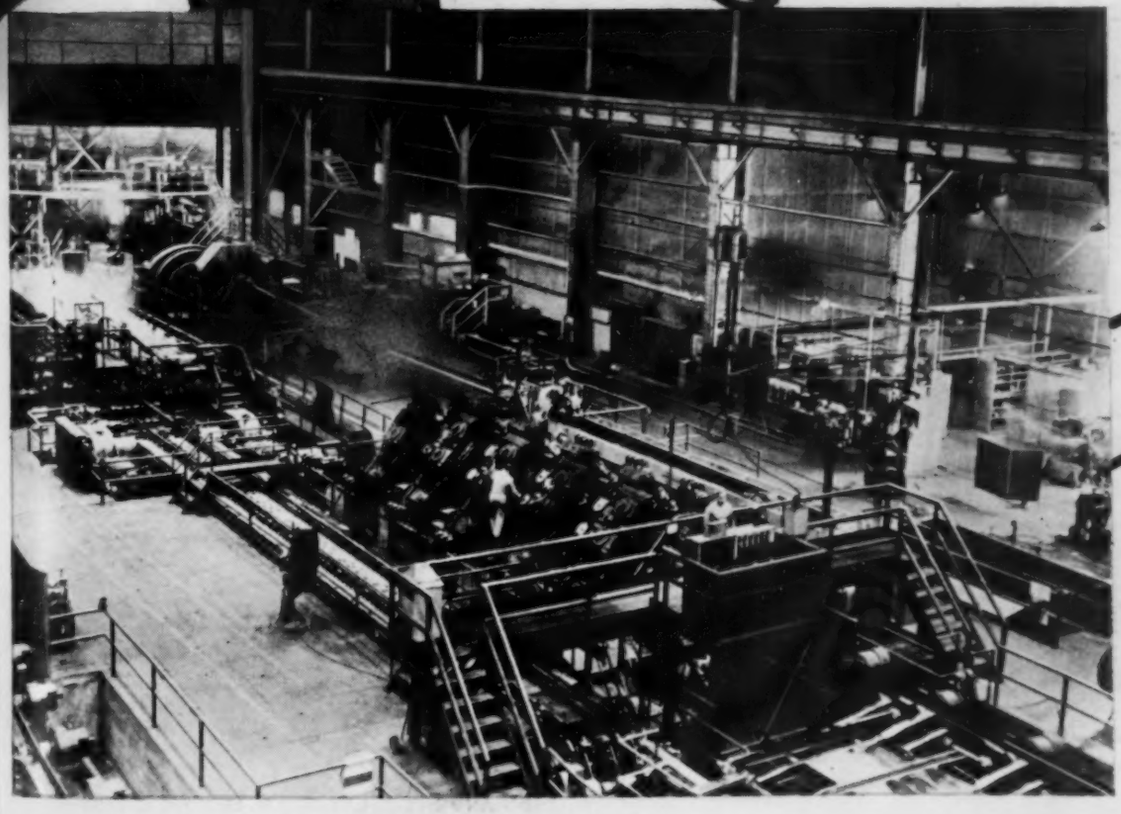
THE AETNA-STANDARD ENGINEERING COMPANY · PITTSBURGH, PA.

Aetna·Standard

PLANTS IN WARREN, OHIO · ELLWOOD CITY, PENNSYLVANIA

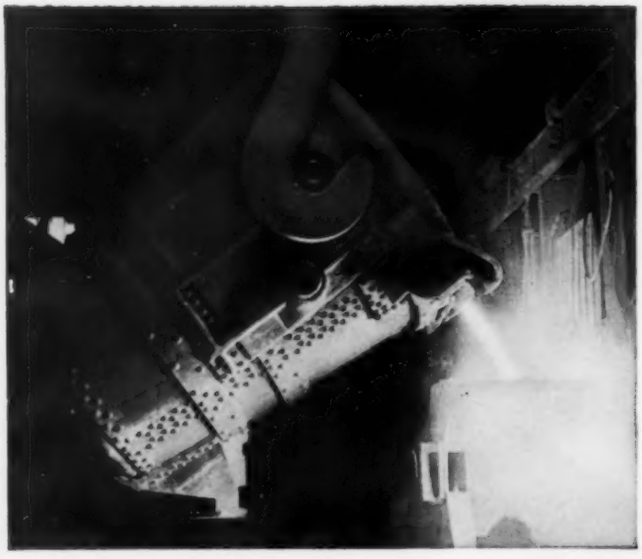
GOOD EQUIPMENT BRINGS DOWN PRODUCTION COSTS

Most of the improvements in equipment for making Seamless Tubing have been worked out between the people who make tubing and Aetna-Standard, who builds the pipe and tube mills. Many times the idea originates with the producer . . . other times with Aetna. Either way, the idea seldom reaches maturity without cooperation of the two. These many years of association have made Aetna-Standard a strong company. They expect to continue to earn steel's respect and confidence by the same combination of brain power and physical facilities.



One of the NEWER IDEAS

The Continuous Seamless Pipe Mill, based on the stretch-reducing principle, has been hailed as "one of the greatest advances in the steel industry during the past 50 years." National Tube and Aetna-Standard worked together several years on this development.



STEEL OUTPUT INCREASED BY 110 TONS PER DAY REPORTS STEEL PRODUCER: Tap-to-tap time reduced from 18 to 12 hours . . . Fuel cut 46% per ton produced . . . Tonnage up 50% daily! That's the job Cities Service Heat Prover helped perform for one of the largest steel producers.

"COMPLETED 30 HOUR TEST IN JUST 6 HOURS!" "We completed what normally would have been a 30 hour test in just 6 hours," writes the Eclipse Fuel Engineering Co. of Rockford, Ill. "We found the Heat Prover equally exact, perhaps more exact than standard commercial testing equipment."

INDUSTRY REPORTS ON FURNACE OPERATION:

PRODUCTION UP, COSTS DOWN WITH CITIES SERVICE HEAT PROVER

THE CITIES SERVICE HEAT PROVER . . . Not an instrument that you buy . . . but a service we supply . . . **FREE!**

Shown above are just two of the many outstanding accounts of the Heat Prover's impressive accomplishments. Wherever a furnace operation is involved, the Heat Prover can help increase productivity by providing:

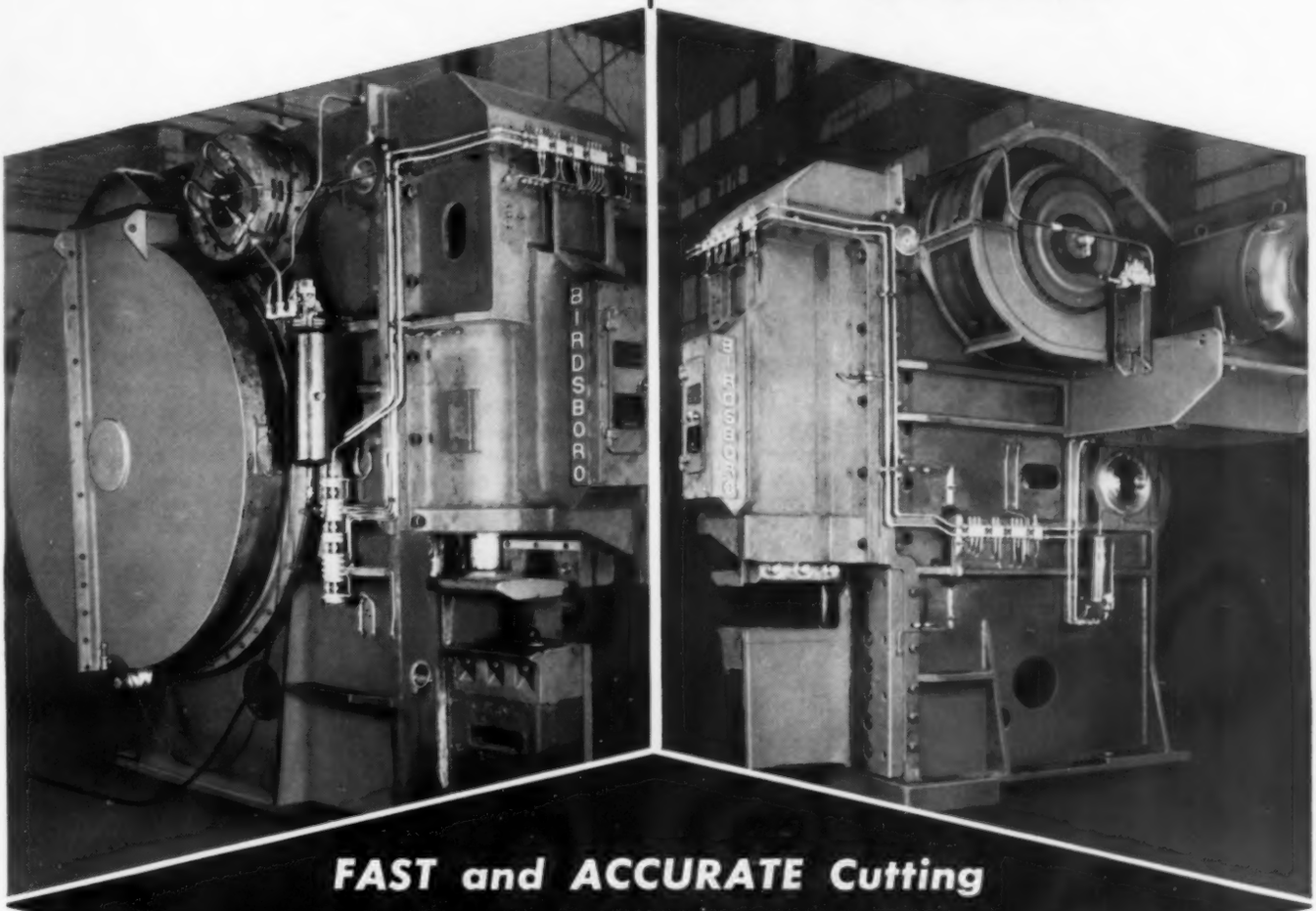
- **Rapid, continuous sampling**
- **Simultaneous reading of oxygen and combustibles**
- **Direct measurement of oxygen and combustibles**
- **Easy portability**
- **Free maintenance and re-calibration service**

Learn how the Heat Prover, supplied and maintained free by Cities Service, can benefit you. For details, contact your nearest Cities Service office or write: Cities Service Oil Company, Sixty Wall Tower, New York City 5, N.Y.

CITIES SERVICE
QUALITY PETROLEUM PRODUCTS

BIRDSBORO

350-TON ↑UP AND ↓DOWN CUT SHEAR



FAST and ACCURATE Cutting

MINIMUM DISTORTION

Designers and Builders of:

STEEL MILL MACHINERY
HYDRAULIC PRESSES
CRUSHING MACHINERY
SPECIAL MACHINERY
STEEL CASTINGS
Weldments "CAST-WELD" Design
ROLLS: Steel, Alloy Iron, Alloy Steel

Two views of the 350-ton Birdsboro Up and Down Cut Shear. Unique up and down action plus heavy clamping gag prevents distortion of plate during shearing. Birdsboro accepts and welcomes the challenge to speed and improve your existing shearing operations. Get in touch with Birdsboro NOW . . . and save from NOW ON.

MM-35-54

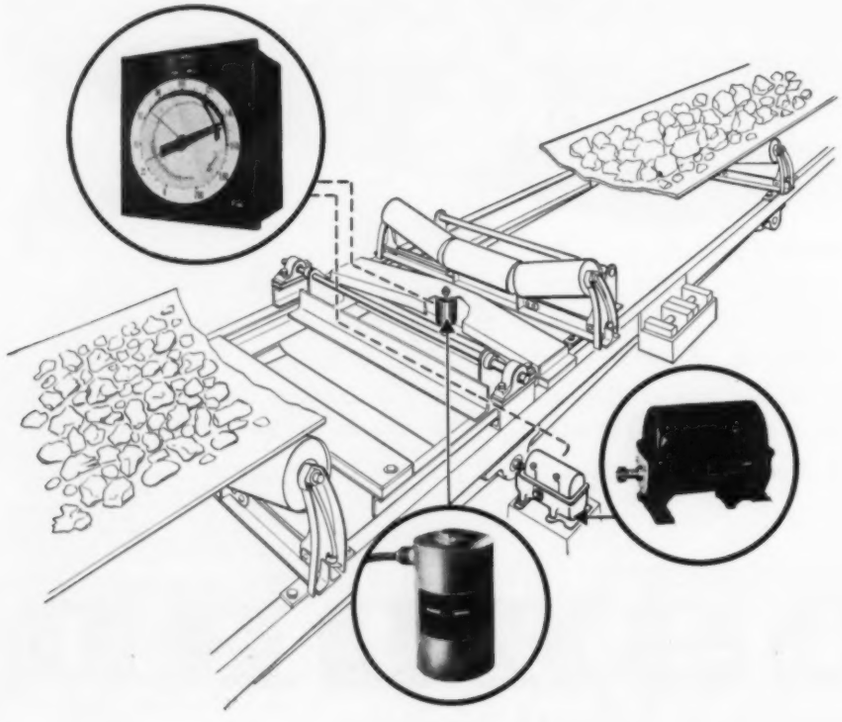
BIRDSBORO

BIRDSBORO STEEL FOUNDRY & MACHINE CO., BIRDSBORO, PENNA. Offices in Birdsboro, Pa. and Pittsburgh, Pa.

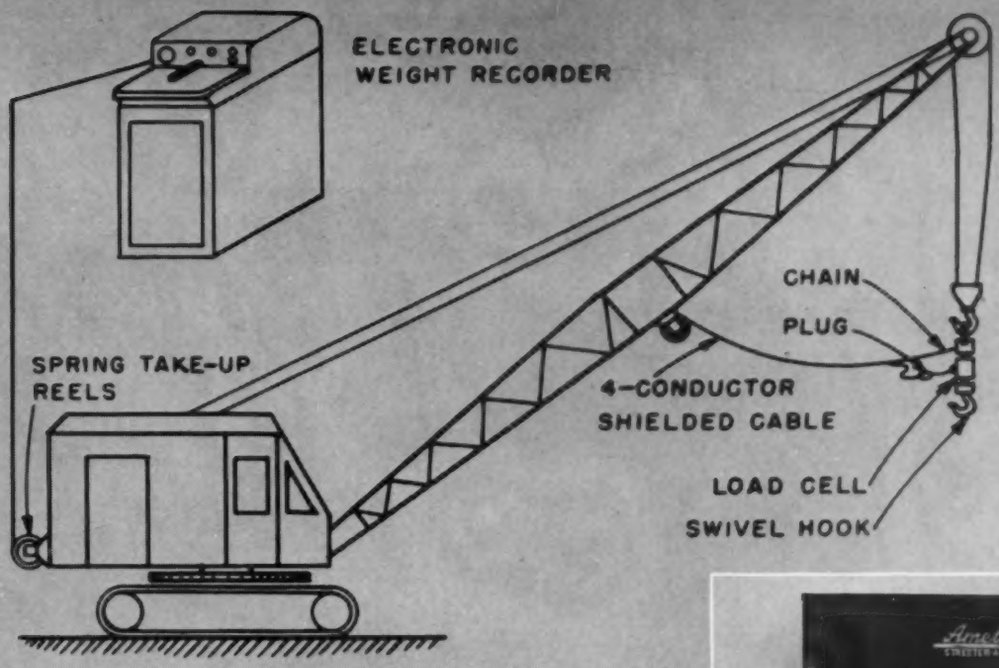
Brown Motion Transmitter is readily adapted to weight measurements by mechanical linkage to a scale beam. The sensing element transmits to an Inductance Bridge Receiver, which indicates, records and controls. Applicable to conveyors, tanks, bins already equipped with mechanical scales. See Data Sheet No. 11.5-2.

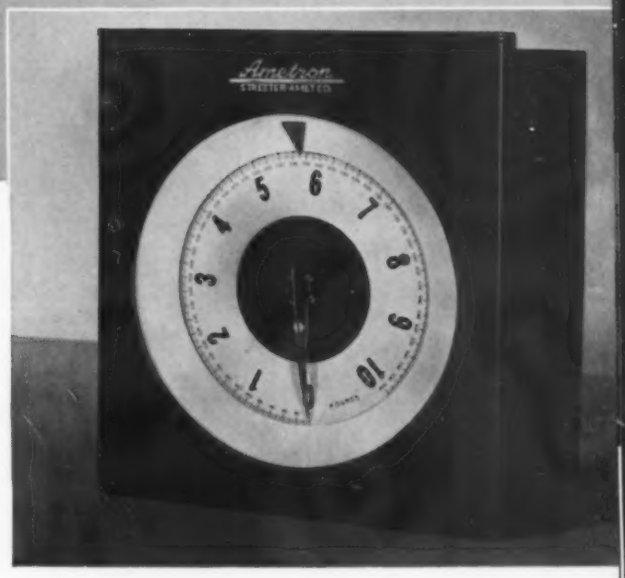
Gilmore Electronic Scale, shown applied to weighing of scrap charge in an open hearth furnace operation, uses Baldwin SR-4 load cells with Brown Servo Amplifier system. This equipment is also applicable to numerous other light and heavy-duty weighing problems. See Data Sheet No. 10.18-4.

Automatic electric weighing systems bring new control ideas



Trans-Weigh Co. ***Belt-Meter*** *weighs materials in transit on belt conveyors and monorails.* ***ElectroniK*** *recorder charts the instantaneous rate of flow of material on the belt, and a special integrating circuit adds up total weight delivered. See Data Sheet No. 10.18-3.*





Ametron Electronic Scale, made by Streeter-Amet Co., utilizes Baldwin load cell with ***ElectroniK*** *amplifier and Brown servo motor to record weight on crane hooks, track scale, overhead cranes (illustrated in diagram).* ***ElectroniK*** *circular scale indicator gives continuous indication of weight. See Data Sheet No. 10.18-2.*

to steel production

MODERN methods of continuous electrical weighing of solids are opening up new avenues of control...new sources of production economy . . . in the steel industry. Utilizing Baldwin-Lima-Hamilton SR-4 load cells, *ElectroniK* recorders and Brown servo components in systems designed by various manufacturers, this technique affords a number of distinct advantages.

Remote measurements are readily made. The electrical strain gage type load cell can be located hundreds of feet from the indicating or recording instrument. This flexibility permits spotting the instrument in a foreman's office, on a central panel, or wherever needed for supervisory purposes.

Versatility. Electrical weighing is applicable to materials on belts or conveyors, on cranes, in hoppers, in railroad cars, in ladles. It is readily installed on existing equipment, usually with only minor modifications required.

Automatic control. Continuous measurements can often be used to initiate automatic control systems for regulating proportions of ingredients, for operating alarms or for other tasks now requiring human attention.

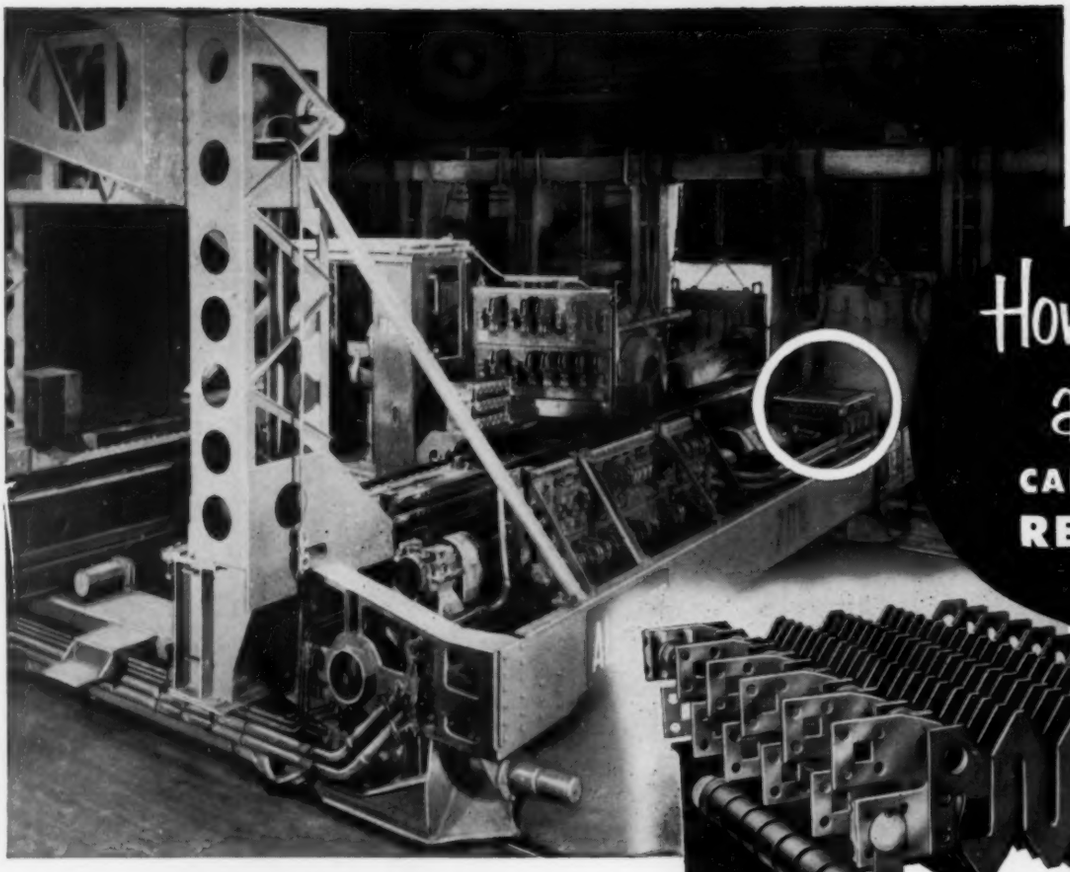
Ruggedness. The inherently sturdy strain gage type load cell units can take 120% overloads without adverse effects . . . are hermetically sealed with no moving parts.

Several typical electrical weighing systems are illustrated here, together with the Brown Motion Transmitter which is also applicable to weight recording. Your nearby Honeywell sales engineer will be glad to discuss your own application . . . or, if you prefer, a representative of the manufacturer of the specific system will consult with you.

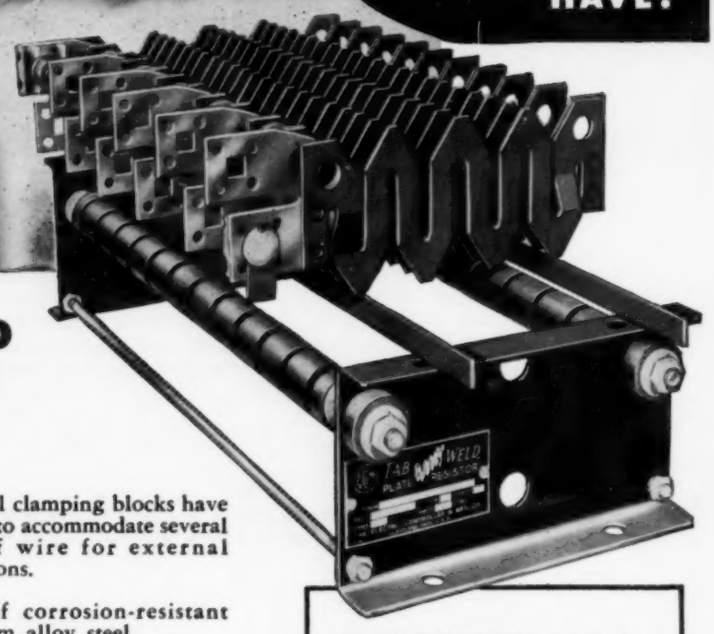
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA: Write for Data Sheets on specific weighing systems, and for Data Sheet No. 10.18-1a, "Baldwin SR-4 Devices."**

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls



How many advantages CAN A RESISTOR HAVE!



ONLY EC&M TAB-WELD PLATE RESISTORS HAVE ALL THESE FEATURES!

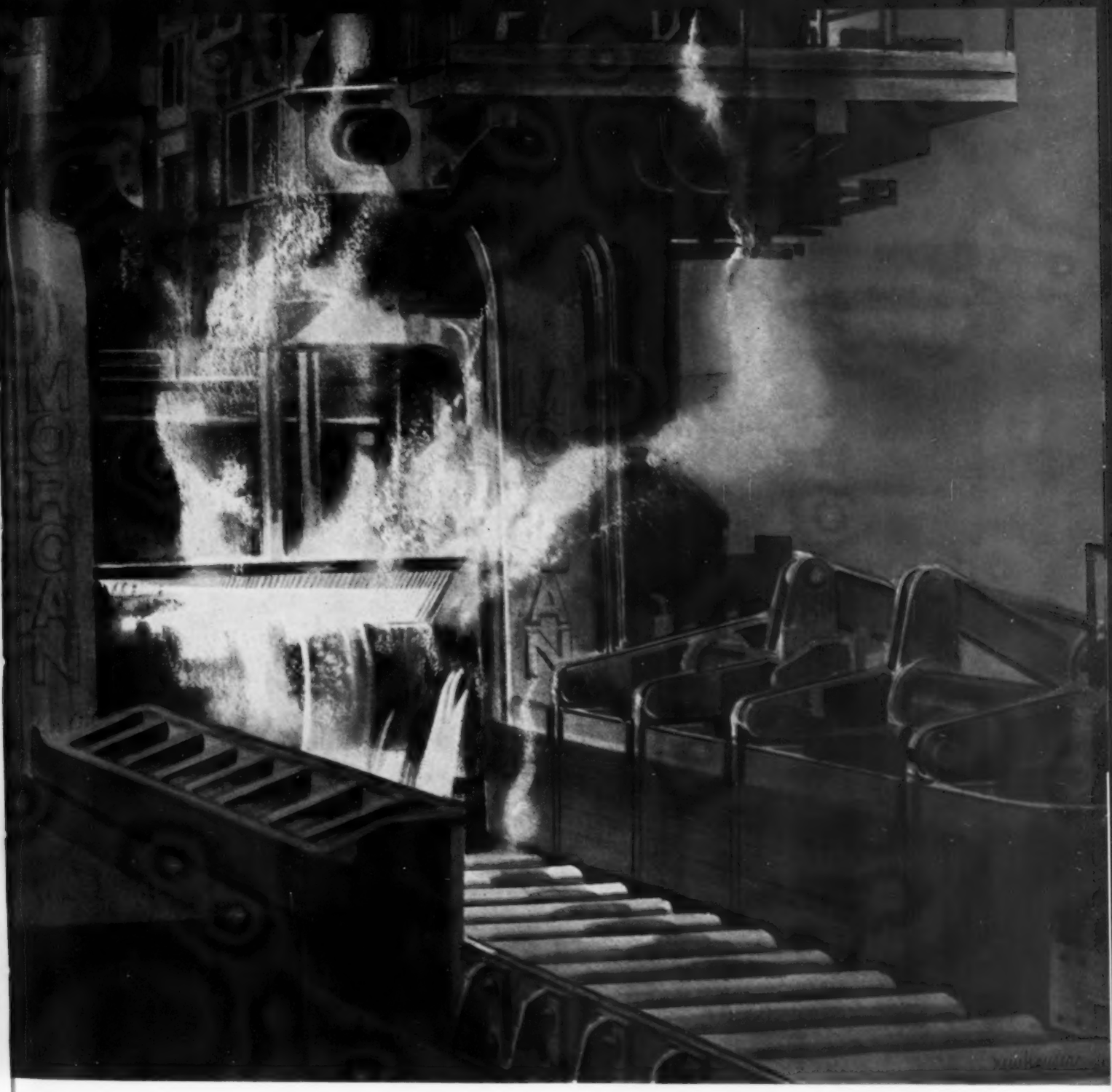
1. Spot-welding of resistor ends, offset to bring adjacent grid eyes into intimate contact, results in permanent current-carrying path throughout the section.
2. No burning at grid eyes.
3. No periodic tightening of clamping nuts.
4. Terminal plates welded to resistor tabs along one side of section. Small adjustments in resistance value easily effected because plates are closely spaced.
5. No burning at taps.
6. Negligible resistance change between cold and maximum working temperature.
7. Insulating spacers of high dielectric strength accurately molded to shape from noncarbonizing material which remains dimensionally stable.
8. Terminal clamping blocks have grooves to accommodate several sizes of wire for external connections.
9. Made of corrosion-resistant chromium alloy steel.
10. Nonbreakable.
11. Double insulation to ground.
12. All standard sections same length, width and height.
13. Standard mill sections built with same size resistors per section.
14. Separate nuts on supporting rods clamp grid-stack independently of end-frame clamping. Accurate mounting-hole dimensions maintained regardless of variation of grid-stack length.

SHUTDOWN AVOIDED! Recently in one installation, a swinging overhead-crane load bumped resistors on charging machine and smashed end-frames and broke several spacers of grid assembly. *Shutdown was avoided* because current-carrying path of EC&M TAB-WELD Resistors remained intact and permitted charging of furnaces to continue. Later when down-time was available, section was replaced and returned to repair shop for new spacers and end-frames. This is another example of the durability of EC&M TAB-WELD Resistors.

Write today for illustrated Bulletin No. 942-B.

1806

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO



MORGANIZATION...maintains production

The reputation for doing its part to maintain plant schedules is built into every Morgan machine . . . cranes, rolling mill, or forging equipment.

Morganization now includes a complete survey of your Morgan equipment by experienced Morgan men. The condition of all parts is checked and reported to your maintenance department. Genuine Morgan parts will help maintain the designed efficiency of the equipment. If improvements should be made to increase this efficiency, our engineers will suggest how to make them at lowest cost.

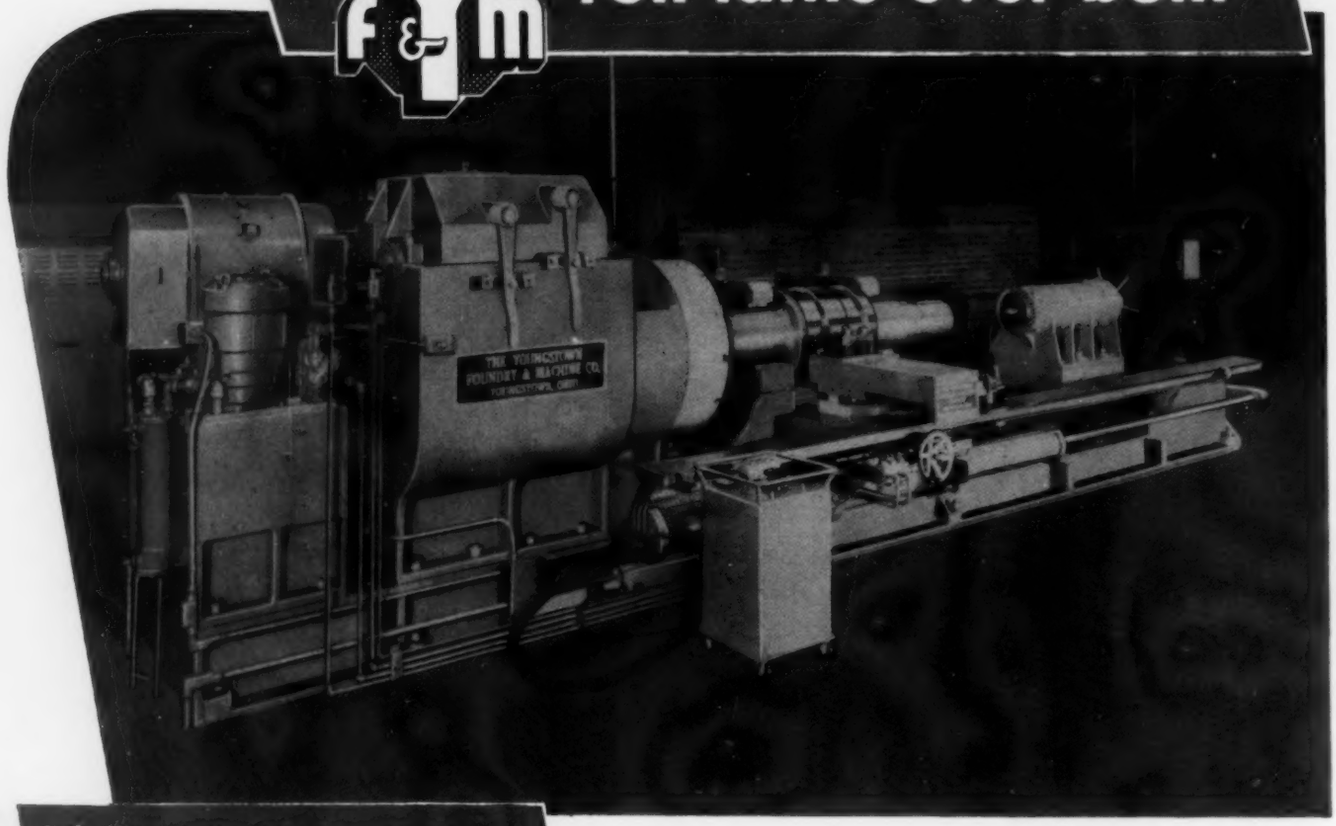
This is another segment of "Morganization". . . designing, building, servicing that makes Morgan Engineering machinery best. Write us for information on Morgan Maintenance Surveys for *your* equipment.

MORGAN ENGINEERING

THE MORGAN ENGINEERING COMPANY, ALLIANCE, OHIO

NOW the most efficient* roll lathe ever built

F & Y m



* Roll Lathe rigidity and finish with Engine Lathe speed and flexibility

* Completely hydraulic tracer control insures smoother, more accurate finish

* Tool post and carriage designed to use either single point carbide-tipped tools or regular roll turning tools

* Ways on carriage and tail stock are non-metallic, which greatly extends service life

* Timken roller bearings throughout; herringbone gearing; automatic lubrication

18

You can turn rolls *better...* either on necks or centers

WITH THIS *New* "YOUNGSTOWN"

36" Contour Roll Lathe

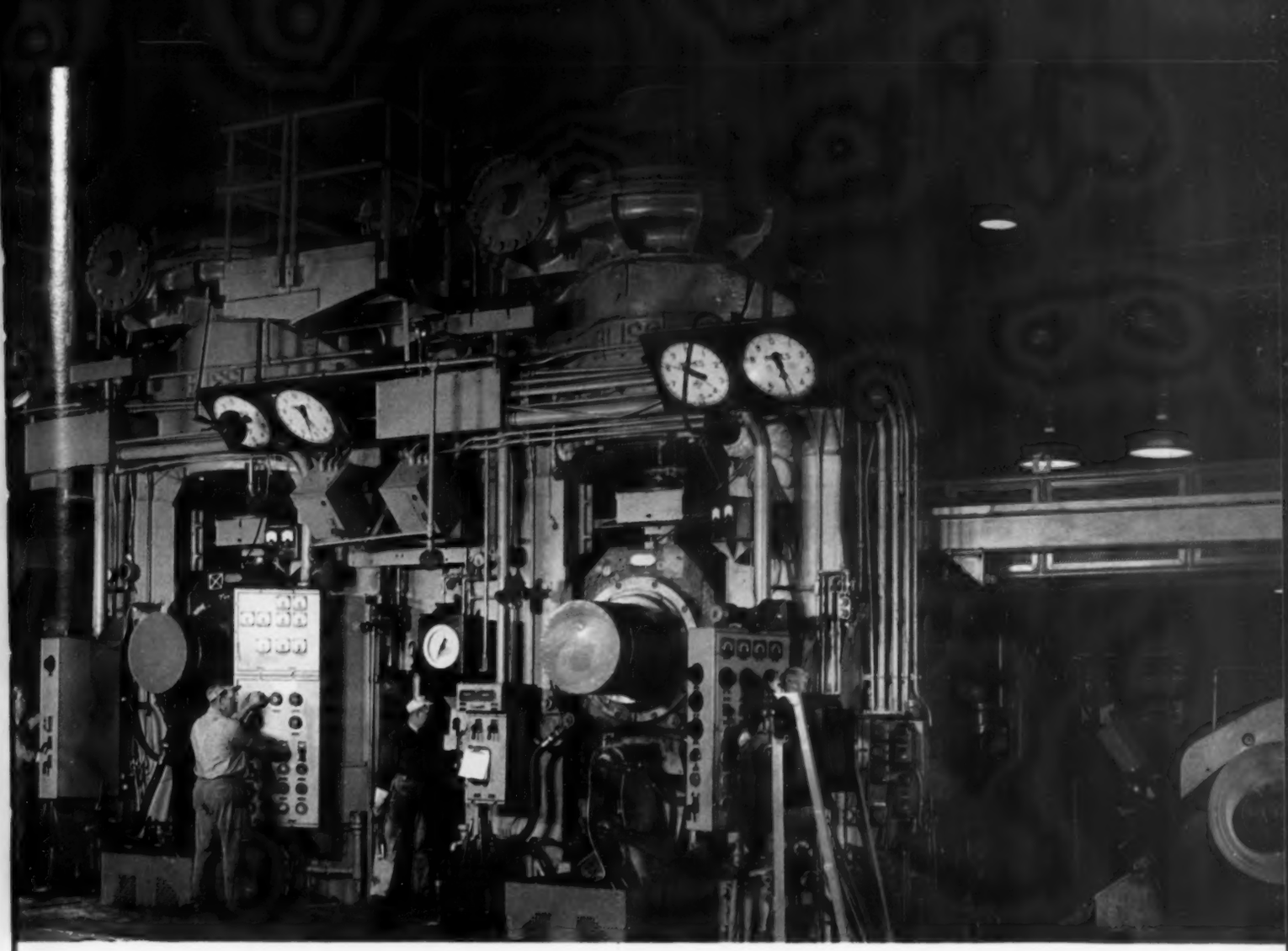
Outstanding in performance! Tested! Proved! This lathe, originally developed and perfected for turning in our own roll shop, turns rolls either on necks or centers. Speed range .75 RPM to 53.5 RPM. Roll capacities: 6" minimum diameter, 36" maximum diameter, with 11'6" maximum length (subject to alterations to suit your specific needs). Your next Roll Lathe if you want the best.

Write for Complete Information

The Youngstown Foundry & Machine Co.

SERVING INDUSTRY SINCE 1885

Youngstown, Ohio



At Jones and Laughlin Steel Corporation...

High Speed Tin Temper Mill

has **RUGGEDNESS** and **POWER** to match

Speed, ruggedness, power and the latest coil-handling equipment . . . characterize this tandem mill at J & L. These features, combined with modern electrical control systems, make this one of the most advanced mills in use today.

Its top-rated speed of more than 6000 fpm furthers the trend to faster, more reliable mills . . . capable of better quality at higher speeds . . . with easier control.

Speed, power and rapid acceleration and deceleration features . . . all these pay off in terms of greater tonnage. In addition, mechanical and semi-automatic coil handling equipment—designed for extra large coils—at entry and delivery ends add to personnel safety and increase the productivity of this mill.

This J & L installation is one of many startling developments in modern mills engineered by Bliss for leaders in the steel and non-ferrous plants both here and abroad. For more information about Bliss rolling mills, write today for Catalog 40-A . . . Bliss' 60-page rolling mill brochure.

Remember: BLISS SINCE 1857 **for Presses, ROLLING MILLS, Special Machinery**

E. W. Bliss Company • General Offices: Canton, Ohio

ROLLING MILL DIVISION: SALEM, OHIO

Subsidiary: The Die Supply Company, Cleveland, O. • E. W. Bliss (England) Ltd. • E. W. Bliss Company (Paris) France

Plants in Canton, Salem and Toledo, Ohio; Hastings, Michigan; and San Jose, Calif. Branch Offices in Chicago, Cleveland, Dayton, Detroit, Indianapolis, New Haven, New York, Philadelphia, Rochester, Toledo and Toronto, Canada. West Coast Representatives: Moore Machinery Co.

P&H MILL TYPE CRANES

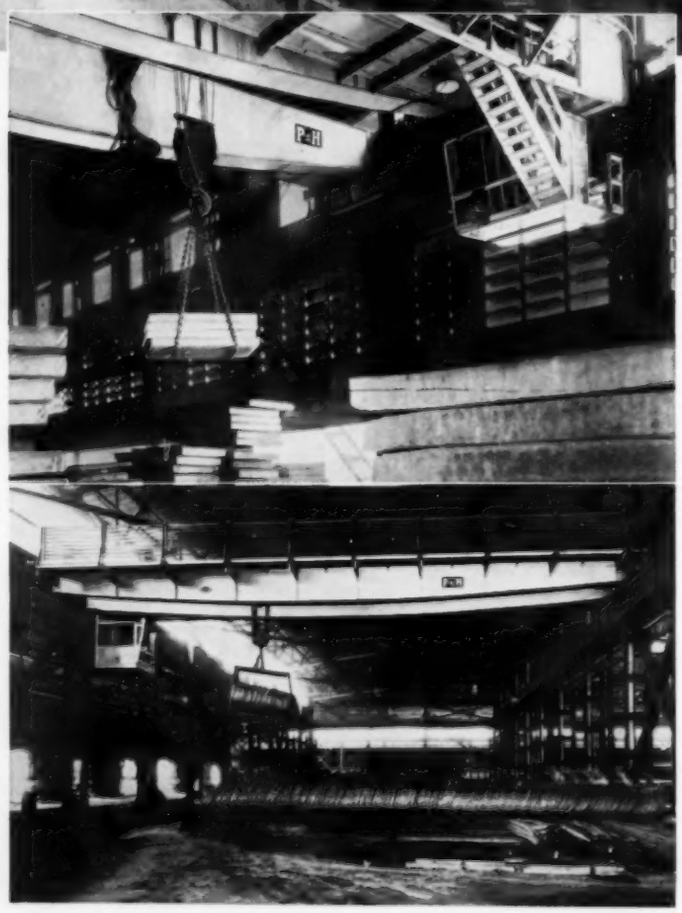
Preferred by Steel Men

because:

P&H Mill Type Cranes are built in excess of the minimum requirements of the A.I.S.E. specification.

This is only one reason why P&H Mill Type Cranes have won such an outstanding reputation. They deliver fine service . . . dependable through the years . . . with fewer interruptions . . . lower maintenance costs.

The overwhelming preference for P&H is evidenced by the fact that there are more than 2,000 P&H Overhead Cranes in steel mill service alone.



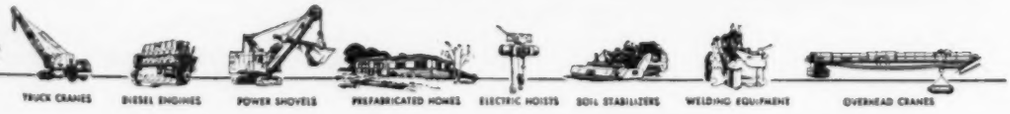
P&H OVERHEAD CRANE DIVISION

HARNISCHFEGER

CORPORATION

MILWAUKEE 46, WISCONSIN

the P&H Line



CONTINUOUS WIRE PATENTING, PICKLING AND COATING LINE

by DREVER

Installed in the plant of
John A. Roebling's Sons Company
Trenton, N. J.

Line Consists of

GAS-FIRED, MUFFLE TYPE HEATING FURNACE
GAS-FIRED IMMERSION TUBE HEATED LEAD QUENCHING BATH
COOLING ROLLS
ACID PICKLE TANK
HOT WATER SPRAY RINSE TANK
COATING TANK

CAPACITY, 3000 LBS./HOUR
HIGH CARBON STEEL WIRE
12 STRANDS 0.112" AVERAGE DIA.

Automatic Controls • Can be Electrically Heated
Substantial Savings in Labor Costs
High Quality Products

Send your inquiries and requirements for equipment to our competent staff of engineers and metallurgists

DREVER COMPANY

760 E. VENANGO STREET • PHILADELPHIA 34, PA.

SLAB TURNING GANTRIES . . . *by "Shaw-Box"*

Slab Turning Gantries are another specialty in the broad "Shaw-Box" Line of steel mill cranes. Numerous outstanding mechanical advantages are contained in them. Among these mechanical advantages are a perfected ratchet device that disengages the hoisting mechanism if the load is carelessly handled preventing trolley being raised off the bridge when engaging slabs; roller guides to guide the ram and prevent swing of mast; a ram that can be removed without disturbing the operating mechanism.

In "Shaw-Box" Slab Turning Gantries — whether built to an individual mill's or A.I.S.E. specifications — you get the added advantages that come from "Shaw-Box" engineering, fine workmanship, and precision manufacturing methods. These added advantages insure crane performance which makes "Shaw-Box" Gantries, for the work they do, the least expensive cranes to buy and use.

SEND ALL YOUR INQUIRIES FOR STEEL MILL CRANES AND SOAKING PIT CARRIAGES TO "SHAW-BOX"

"Shaw-Box" CRANES

MANNING, MAXWELL & MOORE, INC.

Muskegon, Michigan

Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, 'American' Industrial Instruments and Aircraft Products.

TIMKEN® bearings on the axles take shock loads of 110-ton ore car

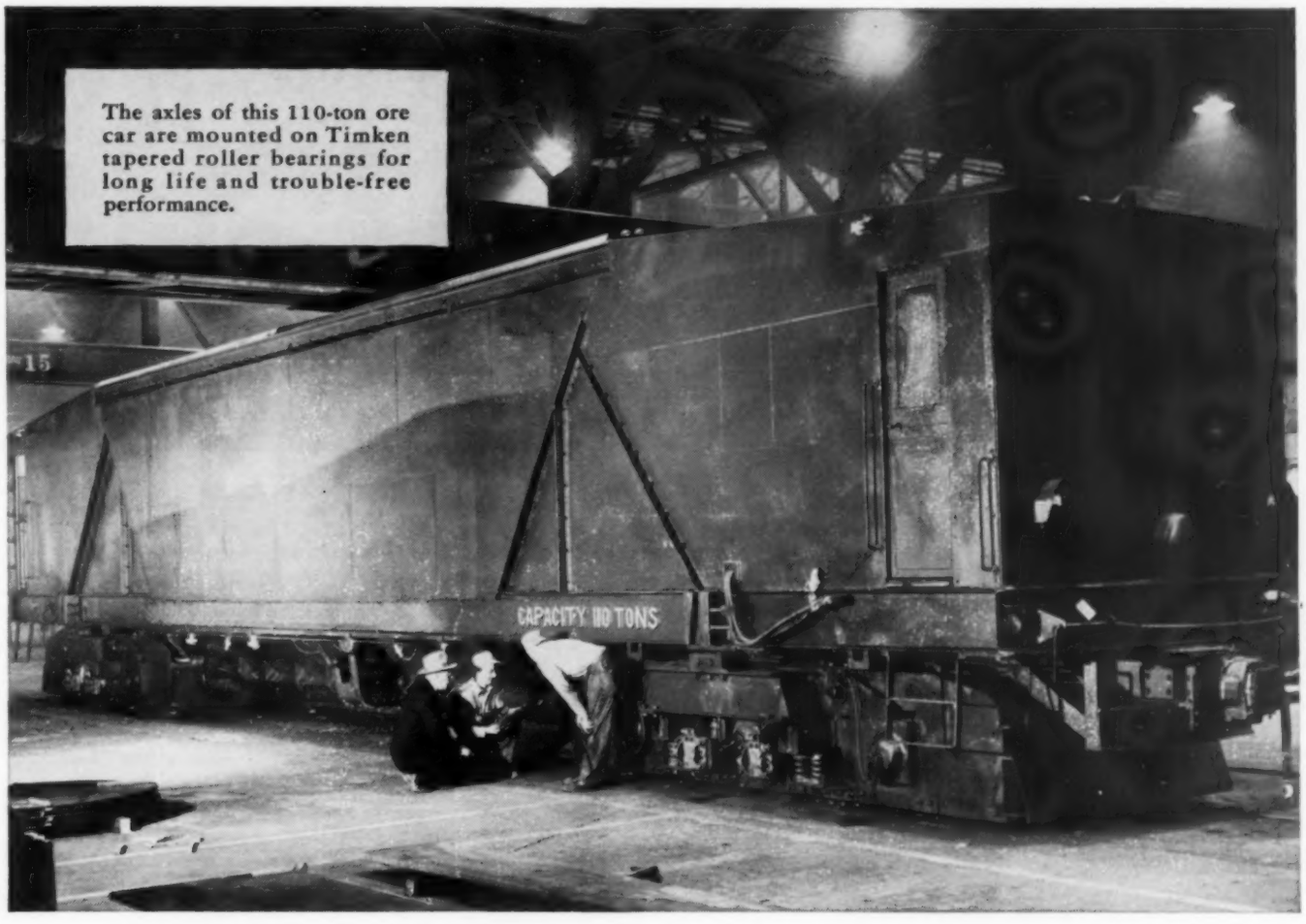
WHEN 110 tons of iron ore are dumped into the ore car pictured below, heavy shock loads hit the bearings on the axles. And when the car bounces over rough track, the bearings have to take repeated shock loads. That's one of the main reasons Timken® tapered roller bearings are used on the axles of this ore car and others like it in a large eastern steel mill.

Timken bearings easily take heavy shock loads because they are case-hardened so that they have tough, shock-resistant cores under hard, wear-resistant surfaces. They take the heavy pounding an ore car gets with minimum time-out for maintenance and repair. And because of full line contact between rollers and races, Timken bearings have extra load-carrying capacity.

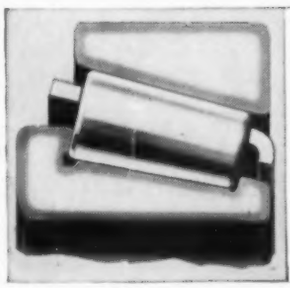
It's easy to start an ore car with Timken bearings on the axles. Timken bearings cut starting resistance 88%. That's because their true rolling motion and smooth surface finish practically eliminate friction.

And since Timken bearings are tapered, they take any combination of radial and thrust loads without the need for costly auxiliary thrust bearings. So whether you're building or buying mill equipment, make sure you get all the advantages only Timken bearings can give. For longer life, less friction, minimum maintenance, always look for the trade-mark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



The axles of this 110-ton ore car are mounted on Timken tapered roller bearings for long life and trouble-free performance.



HARD ON THE OUTSIDE, TOUGH ON THE INSIDE

Rollers and races of Timken bearings are case-carburized to give a hard, wear-resisting surface and a tough, shock-resisting core. Result: longer bearing life.

The Timken Company leads in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis Timken steels.

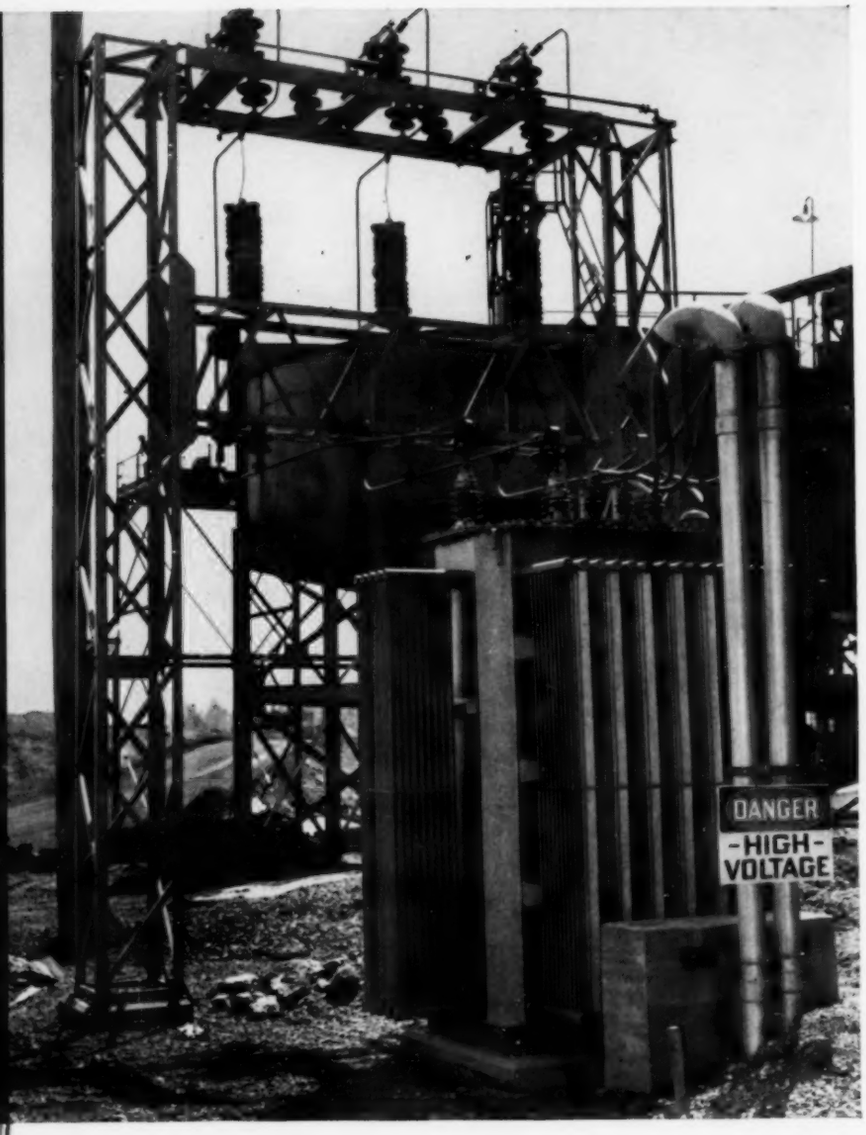
TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

Wagner®
TRANSFORMERS
... the choice of leaders in industry

POWER for a man-sized job...



Taconite is an important word in the Mesabi Iron Country. As the supply of rich ore becomes scarcer, the mining companies are prepared to process taconite and lower grade iron ore for delivery to the nation's steel mills.

Processing taconite is a man-sized job. It is one of the world's hardest ores. It has to be crushed and ground to separate the iron particles from the rock and silica.

During the winter, the temperature in the Mesabi country often drops to 30° below zero. Tough jobs under operating conditions like this call for a plentiful supply of really dependable power. At the Nashwauk, Minnesota, mine of The Cleveland-Cliffs Iron Company, this power is delivered by Wagner Transformers. Shown above is the 3000 kva Wagner Power Transformer that furnishes power for this plant, and at the left is one of the Wagner 1000 kva Unit Substation Transformers that supply plant loads.

Wagner can also furnish motors especially designed for use in taconite plants. Your nearby Wagner engineer can help you select the right transformers or motors for *your* needs. Call the nearest of our 32 branch offices, or write us.

Wagner Electric Corporation
EST. WE 1891

WAGNER ELECTRIC CORPORATION
6483 PLYMOUTH AVE., ST. LOUIS 14, MO., U.S.A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

ELECTRIC MOTORS
TRANSFORMERS
INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS— AIR AND HYDRAULIC

T54-12

BRITISH
STEELMAKERS
depend on
MORGOIL
Roll Neck Bearings
because they
insure accurate products
last a long time
require little maintenance
May we tell YOU more about them?
MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS
English Rep., International Construction Co., 56 Kingsway, London W. C. 2, England
ROLLING MILLS • MORGOIL BEARINGS • WIRE DRAWING MACHINES
REGENERATIVE FURNACE CONTROLS • EJECTORS • GAS PRODUCERS
MB-25
MORGOIL
ROLL NECK BEARINGS

HERE'S THE USG BRUSH

THAT DOES AN OUTSTANDING JOB ON AC CRANE MOTOR RINGS

When you replace the brushes on your AC Crane Motor Rings you can get the best results with U S G Grade 550 Brush. For brushes that give superb results in other applications, see below. Write for your copy of the complete U S G Brush catalog today.

A typical U S G Grade 550 Brush for AC Crane Motor Rings

194

U S G Grade 135 Mill Motor Brush with Statite*

U S G Grade 223 Brush for DC crane motors with Statite*

U S G Grade 1658 Brush for tin line collector rolls

U S G Grade AH897 Brush for welding generators with Statite*

*Permanent shunt connection, needing no hammerclips; cannot be jarred loose or pulled out.

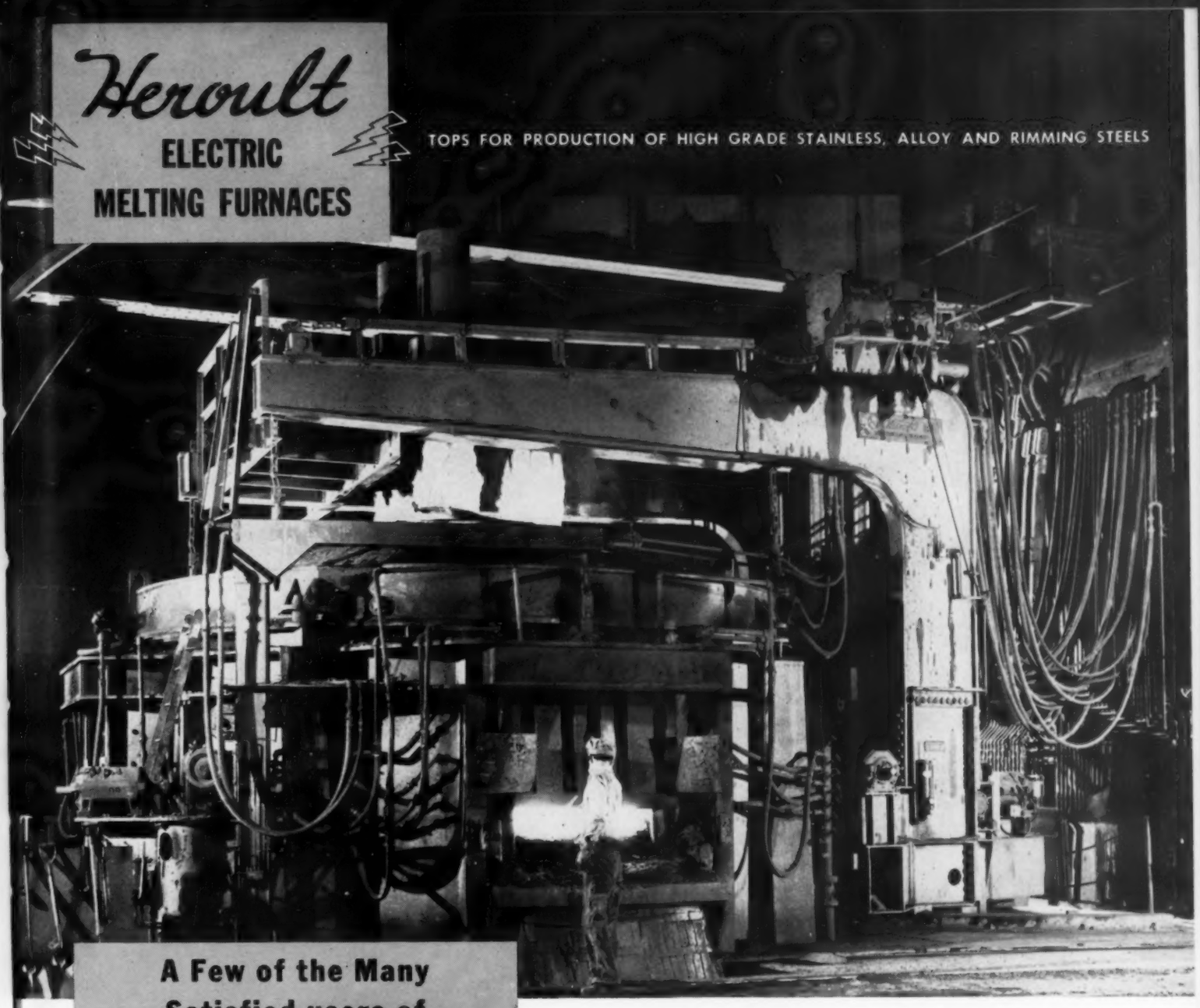
OUR 100th YEAR

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

Heroult
ELECTRIC MELTING FURNACES

TOPS FOR PRODUCTION OF HIGH GRADE STAINLESS, ALLOY AND RIMMING STEELS



A Few of the Many Satisfied users of HEROULT FURNACES

A. M. Byers Company
Allegheny Ludlum Steel Corporation
American Steel Foundries
Crucible Steel Co. of America
Ingersoll Steel Division, Borg-Warner Corp.
McLouth Steel Corporation
Ohio Steel Foundry Company
Republic Steel Corporation
Rotary Electric Steel Company
The Timken Roller Bearing Company
Vanadium-Alloys Steel Company

NEW CATALOGUE NOW READY

Contains up-to-date information on Heroult Electric Melting Furnaces — types, sizes, capacities, ratings, etc. Write Pittsburgh Office for free copy.

Heroult
the standard of efficiency and safety!

Embodying the latest in mechanical and electrical equipment, these widely used furnaces are noted for their efficient performance, safety, and low operating cost and maintenance.

We welcome an opportunity to help you select and install the furnace best suited to your particular requirements.

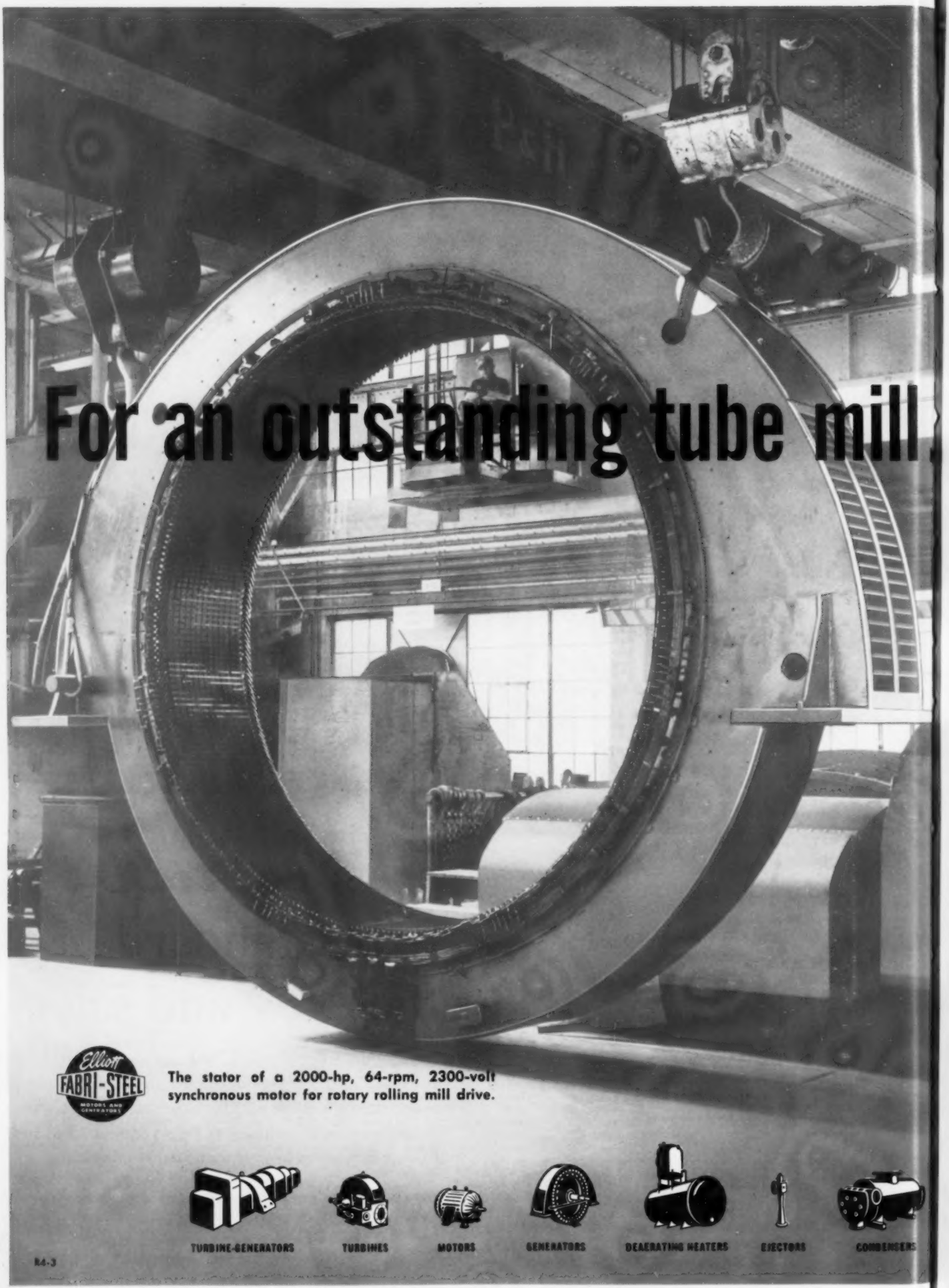
AMERICAN BRIDGE DIVISION, UNITED STATES STEEL CORPORATION
GENERAL OFFICES: 525 WILLIAM PENN PLACE, PITTSBURGH, PA.

Contracting Offices in New York, Philadelphia, Chicago,
San Francisco and other principal cities.
United States Steel Export Company, New York

USS

4-288

UNITED STATES STEEL


For an outstanding tube mill
Elliott
FABRI-STEEL
MOTORS AND GENERATORS
The stator of a 2000-hp, 64-rpm, 2300-volt synchronous motor for rotary rolling mill drive.
TURBINE-GENERATORS
TURBINES
MOTORS
GENERATORS
DEAERATING HEATERS
EJECTORS
CONDENSERS
R4-3

THE NO. 3 SEAMLESS TUBE MILL AT UNITED STATES STEEL'S NATIONAL TUBE DIVISION LORAIN WORKS is the world's largest producer of seamless pipe over 14-in. diameter and has made its mark as the greatest producer of transcontinental seamless pipe lines. This naturally involves top flight efficiency in all elements, and especially in the key units of driving motors. The pictures on these pages show some of the big, rugged Elliott motors that are helping to sustain this high production record.

...ELLIOTT MOTORS

But there is more to the story. In converting the mill from 25-cycle to 60-cycle power, these 60-cycle motors were required to fit existing bearings and bases used by former 25-cycle driving units, thus imposing a limiting design factor. All the motors met this requirement with uniform success, fitting into place within the scheduled short periods of mill downtime, and thus maintaining production with the minimum possible interruption — a noteworthy achievement of Elliott engineering.

Full details on these and other Elliott motors are available from your local Elliott representative, or write direct to Elliott Company, Ridgway Division, Ridgway, Pa.

ELLIOTT Company

COMPRESSORS

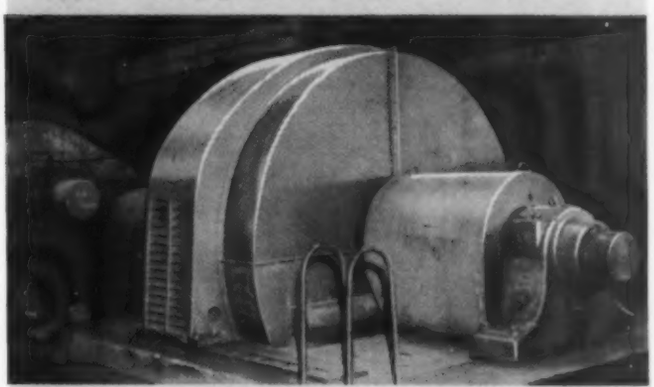
TURBOCHARGERS

TUBE CLEANERS

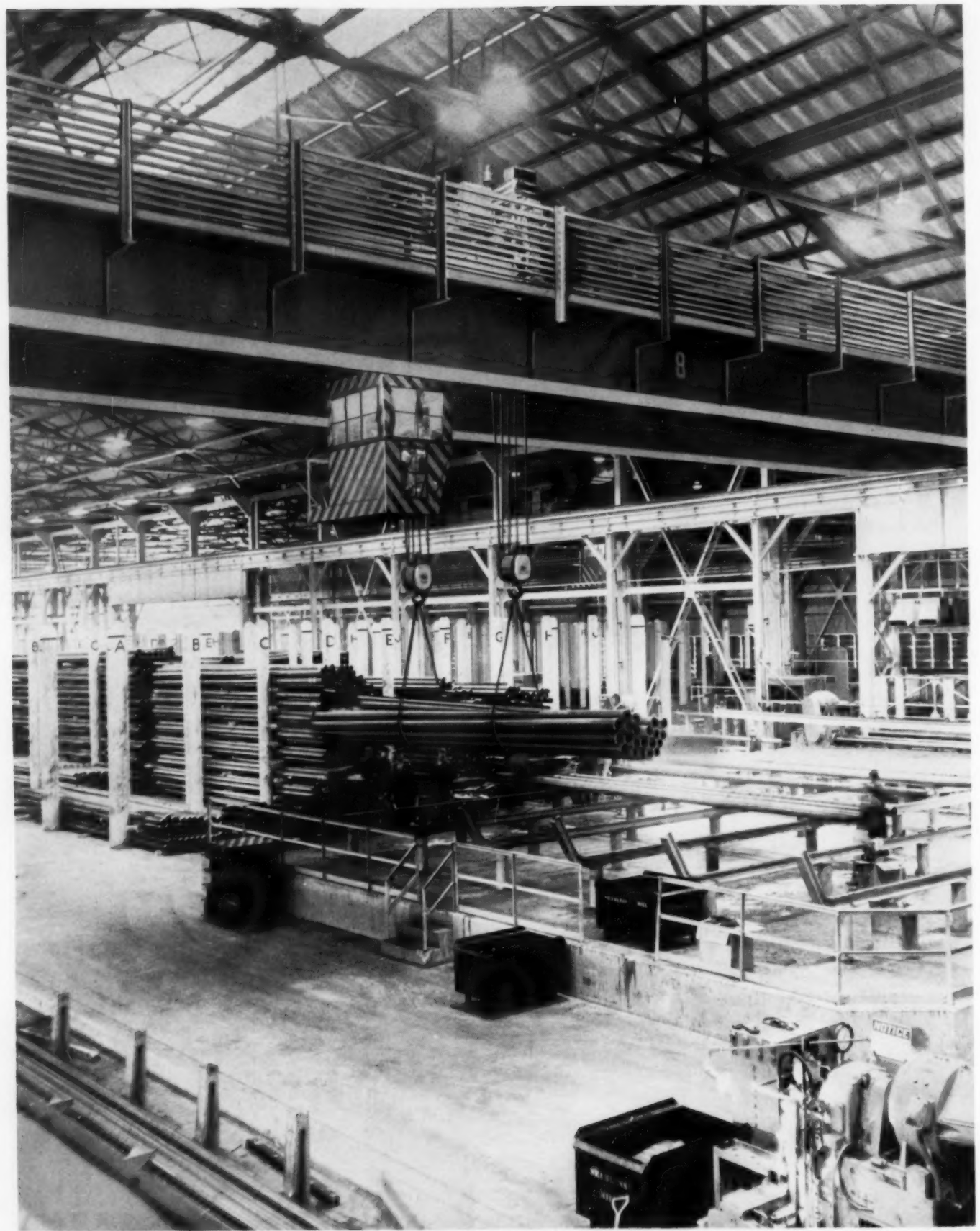
STRAINERS

The East reeler, showing one of two Elliott motors driving reelers. The motors are 600-hp, 380-rpm, squirrel-cage induction motors.

An Elliott 3500-hp, 514-rpm, 13,800-volt synchronous motor driving a d-c generator. Typical of another 2100-hp synchronous motor of similar characteristics supplied for d-c generator drive.


One of two Elliott 5000-hp, 257-rpm, 13,800-volt synchronous motors driving piercing mills.

The completed motor, of which the stator is shown opposite, installed on the driving end of a rotary rolling mill.



CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops *and* Shorts

THE 1954 AISE Convention is now a matter of history, but some facets of it will be long remembered. As the baseball season drew to a close and it became evident that Cleveland would be the scene of part of the world series, the city was swept with excitement and then with consternation when it was realized that the first game in Cleveland was scheduled on the last day of the AISE meeting. Some pressure was exerted to have the convention dates changed — an impossibility in view of the nature of the meeting and the extensive arrangements involved in the Iron and Steel Exposition.

The suggestion that the series be delayed one day uncovered the fact that Cleveland wanted the juicy crowds that were expected on the Friday, Saturday and Sunday week-end. Your editor became known as a "dam-Yankee fan."

The convention opened with a record exposition and good attendance. As the week progressed, new rate cards were posted in two hotels, not applicable to conventioneers but in preparation for the world series crowd.

Friday, the fateful day, came, and things weren't nearly as bad as had been anticipated. Several hotels arbitrarily tried to insist that everyone check out at 9:00 a.m. in spite of signed contracts for a block of rooms for the duration of the convention, which ended that afternoon. Convention-goers for the most part cooperated by checking out early — so much so that there were actually some vacant rooms on Thursday night. The New York Giants were somewhat less cooperative and ended the series on Saturday.

The Association appreciates the cooperation it received from Cleveland and its hotels, particularly the headquarters hotel. It regrets the unpleasant incidents. And the Association is scheduled to return to Cleveland in 1956 and 1958. Fortunately, both dates are the week prior to normal world series time — and of course, the Yankees are still in the league.

▲

APPROXIMATELY $500,000,000 is being spent for taconite processing plants on the Mesabi Range.

Erie Mining Co., jointly owned by Bethlehem Steel Co., Youngstown Sheet and Tube Co., Steel Co. of Canada and Interlake Iron Corp., has a small scale plant at Aurora and is about to spend $300,000,000 on a plant to produce 7,500,000 tons per year of taconite concentrates, with possible expansion to 10,000,000 tons per year. This project, planned for completion in four or five years, involves construction of a new town, Hoyt Lakes, at the mine, and a new port, Taconite Harbor.

Reserve Mining Co., owned jointly by Republic Steel Corp. and Armco Steel Corp., will spend $160,000,000 for a processing plant at Silver Bay. The taconite is mined near Babbitt.

Oliver Mining Co., a United States Steel subsidiary, has spent $23,000,000 to date and has two experimental plants producing 500,000 tons per year of concentrated taconite. They plan commercial development in 1959 and an annual capacity of 10,000,000 tons of concentrate by 1970.

▲

REPORTS from the Securities and Exchange Commission and the Department of Commerce indicate an expenditure of $26,700,000,000 for new plants and equipment in 1954, down about six per cent from last year's record $28,400,000,000.

Well, 94 per cent isn't a bad average.

▲

A man is as young as he feels, but seldom as important.

▲

LAST month, this page commented on the vote of Studebaker workers to accept a wage reduction as a sign of maturing viewpoint. Further evidence of maturity was shown in David J. McDonald's recent speech before the United Steel Workers in Atlantic City. He proposed a "mutual trusteeship" in the steel industry, wherein management would give "full consideration to the just claims of the workers," and unionists would cooperate so "the steel properties are operated successfully."

Mr. McDonald emphasized that if operations are not successful, the workers will not have jobs. He added that managers and employees have an obligation to stockholders.

Recognition of these facts by unions is a fine thing. Let's hope it grows.

▲

AS a result of legislation which puts atomic energy into private industrial fields, Illinois Institute of Technology is offering a new course in nuclear engineering. The course is designed to supplement regular engineering training with a knowledge of nucleonics, so that men in industry will be prepared when atomic energy enters their daily work.

▲

A radically new flexible, ceramic coating, developed by Armour Research Foundation, may be sprayed on almost any solid surface at only a few hundred degrees. The new coating is resistant to chemical attack, even at high temperatures, and it is not brittle.

▲

OBSERVATIONS around Pittsburgh lead us to think that most of the striking unions believe in law and order as long as they can lay down the law and give the orders.

▲

A long range research project, sponsored by the chemical industry, has been established at Carnegie Institute of Technology to provide readily accessible, uniform data on the physical properties of chemical compounds.

Pickling tank and wash tank at Laclede Steel Company. Note the rolls fabricated from tough corrosion- and wear-resistant Ampco Metal. Roll dimensions 31" OD x 29" ID x 36" long. Side plates 34½" OD x ½" thick with 5" ID for shaft.

Here's another roll used at Laclede. Fabricated from money-saving Ampco Metal, it handles six strips at a time.

Laclede Steel
fights wear and corrosion in its pickling line with
AMPCO METAL*

...keeps production up...costs down

Steel companies throughout the country are faced with terrific production problems. Laclede Steel Company, St. Louis, like so many others, found one answer in Ampco Metal.

Shown here is their pickling operation. The tank carries a 12% sulphuric acid solution at 200°F. The strip enters the tank and goes through the entire process via wear- and corrosion-resistant Ampco Metal rollers.

The rollers and side plates are fabricated from Ampco Grade 8 plate. Shafts and nuts are made from extruded Ampco Grade 15.

But resistance to corrosion in pickling service isn't the only important feature of Ampco Metal. It also resists wear, shock, impact. That's why so many mills use Ampco Metal screw-down nuts, slippers, wear plates, flash-welder dies.

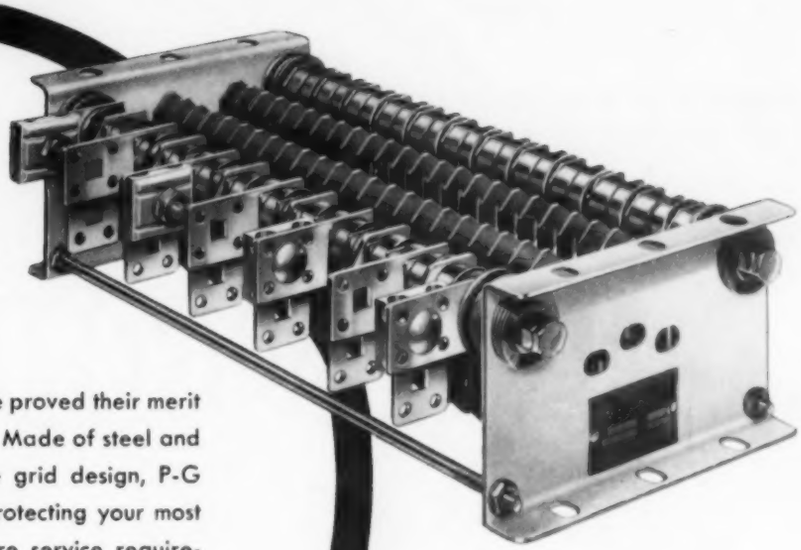
If you have a corrosion problem or a wear problem, it pays to investigate the advantages of Ampco Metal. See your nearby Ampco field engineer or write us for details.

AMPCO METAL, INC.
Dept. IS-10 • MILWAUKEE 46, WISCONSIN
West Coast Plant • Burbank, California

*Reg. U. S. Pat. Off., Ampco Metal, Inc., Milwaukee, Wis.

AMPCO®

G-11



P-G STANDARD
Steel Grid Resistors

These rugged nonbreakable units have proved their merit in all kinds of service for many years. Made of steel and mica, plus P-G unique and exclusive grid design, P-G Standard Resistors are capable of protecting your most vital electrical equipment, even where service requirements are severe. Use of correct resistance value with ample capacity minimizes resistor trouble. ***Write for BULLETIN No. 500.***

P-G has BOTH!

P-G WELDED
Steel Grid Resistors

These units duplicate values of each P-G Standard Steel Grid Resistor. The only change is in adding welding links between resistance grids. Each welding link is made of the same alloy steel used for the grid. These links are heli-arc welded from grid to grid to create a continuous circuit without disruption to the normal path through contact spacers. Thus each P-G Welded Resistor has two paths available for carrying current. Naturally this offers double protection.

Write for BULLETIN No. 510.

P-G

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

THE QUALITY OF SERVICE RENDERED BY...

...LEWIS ROLLS is recognized

by all practical rolling mill men

SUPERIOR "X" ROLLS
AJAX DUPLEX ROLLS
LEWIS "X" AND "XA" ROLLS
SPECIAL PROCESS ROLLS
CLIMAX AND AJAX ROLLS
PLAIN CHILLED ROLLS
SPECIAL TUBE MILL ROLLS
ATLAS, ATLAS "B" AND ATLAS "X" ROLLS
MOLYBDENUM CHILLED IRON ROLLS

BLAW-KNOX

LEWIS ROLLS

Blaw-Knox Company / Rolls Division

Iron AND Steel ENGINEER

T. J. ESS, *Editor*
I. E. MADSEN, *Associate Editor*
T. A. KOCIS, *Production Manager*

Board of Directors

PRESIDENT
E. L. ANDERSON
Superintendent, Electrical Department
Bethlehem Steel Co.
Johnstown, Pa.

FIRST VICE PRESIDENT, JOHN H. VOHR, *General Superintendent,* United States Steel Corp., Gary Steel Works, Gary, Ind.

SECOND VICE PRESIDENT, W. H. COLLISON, *Assistant General Superintendent,* Blast Furnace Division, Great Lakes Steel Corp., Ecorse, Mich.

TREASURER, J. D. O'ROARK, *Assistant Manager, Department of Service and Maintenance,* Weirton Steel Co., Weirton, W. Va.

SECRETARY, LEONARD LARSON, *Chief Engineer,* Republic Steel Corp., Cleveland, Ohio.

PAST PRESIDENTS: I. N. TULL, *Electrical Superintendent,* Republic Steel Corp., Cleveland, Ohio.

J. L. YOUNG, *Vice President, Engineering,* United States Steel Corp., Pittsburgh, Pa.

HONORARY DIRECTORS: JAMES FARRINGTON, *Retired,* Steubenville, Ohio.

L. F. COFFIN, *Assistant General Manager,* Bethlehem Steel Co., Sparrows Point, Md.

DIRECTOR-AT-LARGE: EMIL KERN, *Vice President in Charge of Engineering,* Allegheny Ludlum Steel Corp., Brackenridge, Pa.

DIRECTORS: J. A. BELL, *Chief Engineer,* Bethlehem Steel Co., Bathlehem, Pa.

P. L. WALTER, *Mechanical Superintendent,* Republic Steel Corp., Canton, Ohio.

GEORGE BRENGELMAN, *Assistant General Superintendent,* Tennessee Coal and Iron Division, United States Steel Corp., Fairfield, Ala.

O. K. SHARP, *Superintendent, Bloom and Billet Mills,* Republic Steel Corp., Buffalo, N. Y.

C. E. HOMER, *Superintendent of Maintenance and Power,* The Youngstown Sheet and Tube Co., East Chicago, Ind.

WALTER V. MAGEE, *Assistant Chief Engineer,* American Steel and Wire Division, United States Steel Corp., Cleveland, Ohio.

HARRY W. CLARK, *Open Hearth Metallurgist,* Steel Division, Ford Motor Co., Dearborn, Mich.

J. E. GRAF, *Chief Engineer,* Jones and Laughlin Steel Corp., Pittsburgh, Pa.

A. F. KRITSCHER, *Assistant Chief Engineer, Process Development,* National Tube Division, United States Steel Corp., Pittsburgh, Pa.

D. C. McCRADY, *Superintendent, Electrical Department,* The Steel Co. of Canada, Limited, Hamilton, Ontario, Canada.

WILLIAM M. SCHUCK, *Lubrication Engineer,* Armco Steel Corp., Middletown, Ohio.

P. E. THOMAS, *Assistant General Superintendent,* United States Steel Corp., Gary Steel Works, Gary, Ind.

J. N. IMEL, *Superintendent Continuous Strip and Sheet Department,* Jones and Laughlin Steel Corp., Pittsburgh, Pa.

Managing Director
T. J. ESS
Empire Building
Pittsburgh, Pa.

OCTOBER, 1954 VOLUME XXXI NUMBER X

In This Issue

Patent Reviews — By Melvin Ford, Patent Attorney, Detroit, Mich. 23
The Economics of Replacement in the Steel Industry — By G. G. Beard, President and General Manager, United Engineering and Foundry Co., Pittsburgh, Pa. 55
Pumpability of Steel Mill Greases —
Part I — By J. S. Aarons, Lubrication Chemist, National Tube Div., United States Steel Corp., Pittsburgh, Pa. 67
Part II — By R. G. Warren, Assistant Superintendent, Yard and Transportation, United States Steel Corp., Edgar Thomson Works, Pittsburgh, Pa. 71
Activated Alumina for the Maintenance of Gas Engine Crankcase Oils — By Dr. L. B. Sargent, Jr., Assistant Chief, Lubricants Div. and Dr. E. M. Kipp, Chief, Lubricants Div., Aluminum Research Laboratories, Aluminum Co. of America, New Kensington, Pa. 73
Atomization of Liquid Fuels by High Pressure Natural Gases — By George Grosvenor, Open Hearth Superintendent, Colorado Fuel and Iron Corp., Pueblo, Colo. 77
Temper Mill Control — By George P. Dirth, Electrical Engineer, Granite City Steel Co., Granite City, Ill. 81
AISE Annual Convention — Pictorial Review 94
Processing and Drawing of Steel Wire — By P. A. Beaman, Manager, Wire Machinery Dept., Morgan Construction Co., Worcester, Mass. 96
Application of Magnetic Amplifiers — By Robert J. Weesner, Assistant Chief Application Engineer, The Louis Allis Co., Milwaukee, Wis. 101
Use of Low Pressure Carbon Dioxide for Fire Control — By H. V. Williamson, Director of Research, Cardox Corp., Chicago, Ill. 107
Use of High Velocity Burners for Edge Heating Skelp — By G. J. Campbell, Assistant Fuel Engineer, Bethlehem Steel Co., Sparrows Point, Md. 111
Design and Application of Conveyor Belts for the Steel Industry — By Donald T. Scheu, Belting Engineer, The B. F. Goodrich Co., Akron, Ohio. 117
Current AISE District Section Meeting Notices 123
AISE Kelly Award Winners 124
U. S. Steel Expands Continuous Annealing Facilities — By G. J. Hay, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa. 127
Inland Steel Solves Firebrick Handling Problem 128
Restoration Completed on First Ironworks in U. S. 133
Vertical Tin Plate Annealing Furnace Line to go to Wales 137
A Continuous Billet and Slab Grinding Line — By James MacGregor, Board Chairman, York-Gillespie Manufacturing Co., Pittsburgh, Pa. 138
Tandem Cold Mill Completes Rebuilding Program at Allegheny Ludlum 141
Date-Line Diary 147
Industry News 159
Personnel News 179
Equipment News 199
Book Reviews 211
Index to Advertisers 219

Published Monthly by

ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING
PITTSBURGH 22, PENNSYLVANIA

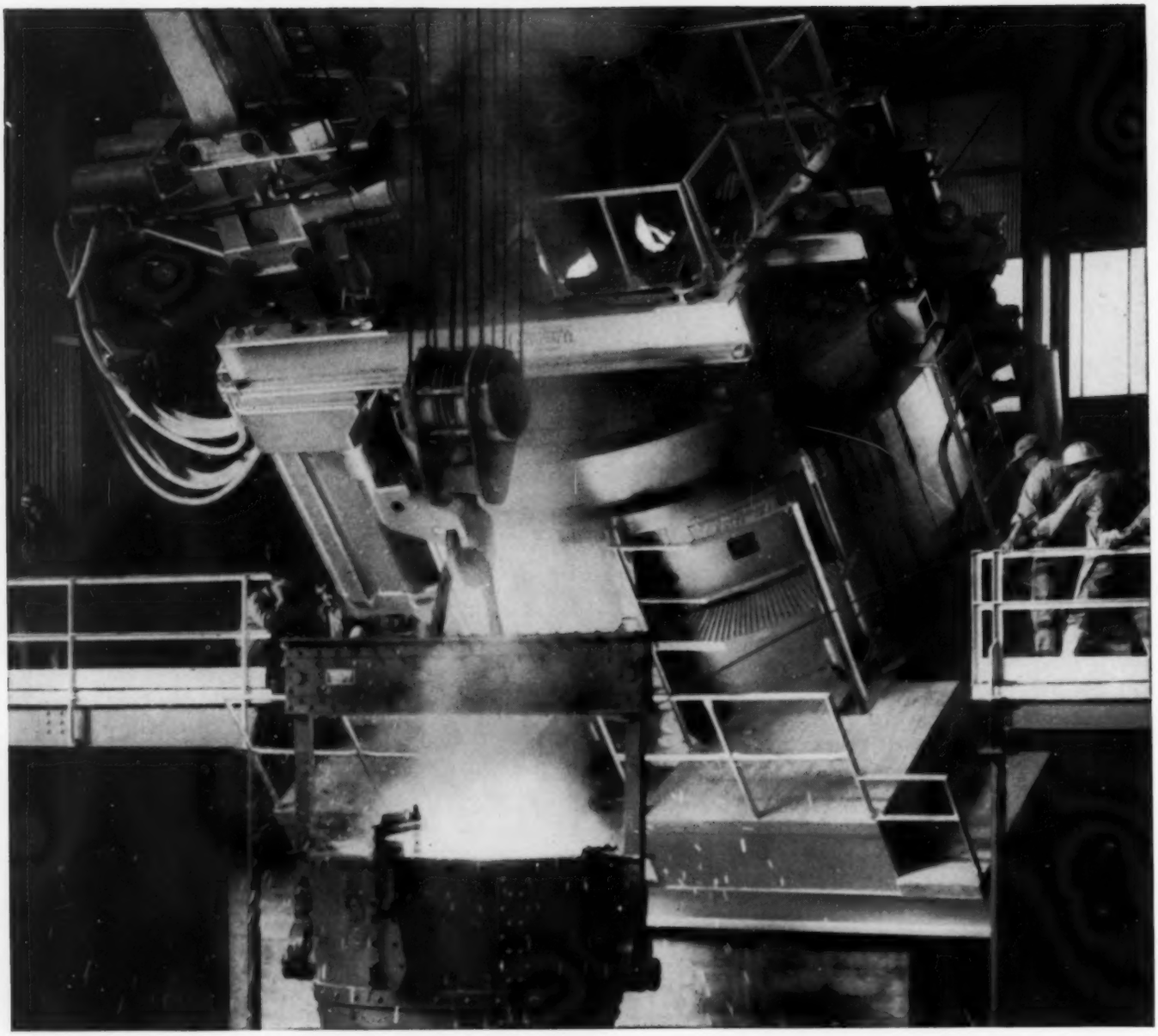
Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

Copyright, 1954, The Association of Iron and Steel Engineers.

Indexed by Engineering Index and by Industrial Arts Index.

Single Copy Foreign Prepaid $2.00 Single Copy $1.50
Subscription price in U. S. and Canada (U. S. funds) ..... $ 7.50 per year
Subscription price in foreign countries ..... $10.00 per year

PLASTIC BINDING U. S. PATENT NO. 1970339 LICENSE NO. 139



*Lectromelt** FURNACES...preferred all over the world

Its many outstanding features have made Lectromelt the favored furnace in 35 nations for melting, smelting, refining or reduction.

- Power supply and power regulation are engineered specifically for each installation.
- Lectromelt provides more precise control of temperature and analysis.
- Top charging saves on labor, power, furnace lining and electrodes.
- Roof lift and swing mechanism is separately mounted.
- Lectromelt furnaces have a reduced inertia electrode mechanism.
- Tilt mechanism is side mounted.
- Each furnace is floor assembled in our factory for assured mechanical operation.

Pittsburgh Lectromelt Furnace Corporation, 310 32nd Street, Pittsburgh 30, Pa.

Manufactured in . . . ENGLAND: Birlec, Ltd., Birmingham . . . FRANCE: Stein et Roubaix, Paris... BELGIUM: S. A. Belge Stein et Roubaix, Bressoux-Liege... SPAIN: General Electrica Espanola, Bilbao . . . ITALY: Forni Stein, Genoa. JAPAN: Daido Steel Co., Ltd., Nagoya

*REG. T. M. U. S. PAT. OFF.

WHEN YOU MELT.. MOORE RAPID *Lectromelt*

The Economics of Replacement in the Steel Industry

By G. G. BEARD, President and General Manager, United Engineering and Foundry Co., Pittsburgh, Pa.

. . . . it is extremely difficult to establish the time when equipment should be replaced . . . . the following procedures have been adopted by much of American industry . . . .

▲ THE importance of technological advancement in the United States cannot be overstressed. In this age our survival depends, among other things, on technological progress and increased production. These elements are so vital in a modern economy that American industry must always keep them within its sights to insure the maintenance and furtherance of our well-being and standard of living.

We are familiar with the industrial stagnation which took place in recent decades in European countries, but following World War II there has been evidence of an industrial revival in that area. During the last administration, the President's Scientific Research Board reported:

"The future is certain to confront us with competition from other national economies of a sort we have not hitherto had to meet. Many of these will be state-directed in the interest of national policies. Many will be supported by new, highly efficient industrial plant and equipment—by the most modern technology. The destructiveness of the recent war makes it inevitable that much of Europe, in rebuilding its factories, will soon possess an industrial plant more modern than ours of today."

Fortunately for us, our own economy has not been afflicted with industrial stagnation. American management has done a better job of keeping their equipment up to date. As long as we continue to further industrial progress through maintenance and improvement of our manufacturing facilities, we will remain a free nation, but if we fail, we leave ourselves open to interference from the state and ultimately state control with all its attending evils.

Technological progress and increased production cannot be furthered by the introduction of new facilities alone, utilizing new methods and processes, leaving existing plant and equipment to ultimately deteriorate through constant use. The investment involved in existing equipment is of such magnitude that it is impractical to discard all that we have to meet the challenge of the future. Sound finance and practicability dictate that existing facilities, so long as they remain commercially operatable, should remain in service. There comes a time, however, when certain facilities can no longer be operated efficiently or at a profit. We must be in a position to know when this occurs and to properly determine such a problem a sound equipment analysis program is essential. In the face of maladjusted taxation, adverse depreciation policies, rising labor costs, and other handicaps, with which industry is faced, our responsibility is a tougher job today than it ever was, but despite these handicaps the area of possible accomplishment is immense.

Replacement problems are beginning to be recognized in their true light and their solution is being attacked on a more logical and scientific basis than heretofore. In this connection, we will discuss the work of the Machinery and Allied Products Institute, which shall hereafter be called MAPI. Their method of analysis is already in use with much success in many companies and in our own company no appropriation for new equipment or facilities to replace existing equipiment is sanctioned unless a MAPI analysis indicates the replacement is justified.

THE NATURE OF REPLACEMENT

Let us first consider briefly the nature of replacement. Strange as it may seem, the general conception of replacement throughout a large section of American industry is that of a requisite of filling the void left by

the physical failure or deterioration of existing equipment and to disregard the effect of external technological and economic changes. While physical deterioration is important in limiting the usefulness of machinery, it should be secondary to external change in today's economy. Today, scientific and technical progress moves at such a pace that existing machinery is apt to be displaced rather than replaced at the time of physical failure. For example, the ice box has been displaced by the refrigerator; synthetic fabrics are displacing natural fabrics such as wool and silk; the jet engine is displacing the piston engine; electrolytic tin plate is displacing hot-dip tin plate; in steel plants continuous processes are displacing older hand or unit production methods; and so on.

Replacement, however initiated, may involve:

1. *Replacement of one machine or piece of equipment by a newer model of the same.*
   Example: Blast furnace replaced by a newer furnace, rolling mill by a new mill, in each case the new facilities providing improved operations, resulting in increased production and/or a reduction in operating costs.
2. *Replacement of one machine by a totally different machine.*
   Example: A rolling mill for special sections by an extrusion press or a flame cutting operation by a machine cutting operation or vice versa.
3. *Replacement of a group of facilities by another group.*
   Example: Replacement of a group of annealing furnaces by a group of furnaces of a different type, using a different fuel.
4. *Replacement of a hand operation by a machine or group of machines.*
   Example: Replacement of a hand scraping or scarfing operation by a mechanical operation, or replacement of a hand feed roll lathe operation by an automatic follower operation.
5. *Replacement of outside subcontracting by a machine, group of machines, or complete facility.*
   Example: A non-integrated steel plant replacing semi-finished steel purchased from others by the installation of its own steelmaking facilities.
6. *A combination of replacement and expansion of capacity.*
   Example: The introduction of a new machine or facility whereby cost, quality, or sales appeal is improved, warranting an expression of capacity due to greater market for the product involved.
7. *An expansion of capacity unaccompanied by replacement.*
   Example: The addition of capacity by similar equipment or newer design of the same equipment without replacement of existing equipment.

In any plant-wide or company-wide replacement analysis, the largest grouping of equipment under consideration for replacement should be analyzed before any analysis of individual units. The reason for this is that, while it is possible to have the most efficient unit for each individual operation, it is also possible to have a group of operations or the entire plant replaceable as a whole.

REPLACEMENT POLICY

Having examined the nature or definition of replacement, let us now take a look at popular methods of determining replacement policy with a view to identifying their deficiencies.

First in popularity is the application of so-called "business judgment," supported on occasion by some favored "rule-of-thumb." We cannot quarrel with business judgment since its proper application to the problem as a whole is indispensable. No magic formula exists as a substitute for sound business judgment, but rules-of-thumb can be very misleading. Rule-of-thumb management is out of date.

To illustrate the fallacy of rule-of-thumb methods, as pointed out by MAPI, take a question posed to 560 companies by the trade journal, "Iron Age," in 1947: "If you would replace existing machine tools before they are actually worn out physically, how much saving in per cent of cost of new machine tools would have to be shown to induce their purchase?" The magazine received replies all the way from 10 to 100 per cent.

Some companies do not even go as far as to use a rule-of-thumb. They literally play a "hunch" after much weighing of pros and cons with little or no analysis whatsoever. Both of these methods are dangerous and likely to produce detrimental results.

There is no substitute for reliable analytical methods. Some method is better than none. To those who may be uncertain of the methods of analysis employed in their organization, it is recommended that consideration be given to the MAPI formula.

THE MAPI FORMULA

The interest which MAPI has in replacement might be construed as a selfish one since it is recognized that the development and dissemination of sound standards for equipment replacement will expand the demand for new equipment, to the benefit of the manufacturers they represent. However, MAPI, in undertaking the investigation it did, considered the results as beneficial to its member companies to be of secondary importance. In support of this statement, the following is quoted from the MAPI publication, "Dynamic Equipment Policy":

"While the significance of the study to machinery manufacturers is thus quite obvious, this is secondary, in our judgment, to its significance for the country at large. A dynamic equipment policy means a dynamic economy. It means a more rapid increase in the standard of living and in national well-being. It means a better competitive position in international trade. It means greater strength and security as a world power."

MAPI has presented a method of analysis which will give you an indication of when a machine or facility should be replaced. The theory is fundamentally sound, and the method of analysis reduces to a minimum the amount of "business judgment" necessary to finalize the results of any analysis.

With the passage of time, deterioration and obsolescence become characteristics of any machine, group of machines, or plant. Certain equipment will de-

teriorate before it becomes obsolete and vice versa. Whatever the combination of deterioration and obsolescence may be, time will accentuate the difference between the operating performance of equipment in use, and the performance obtainable from its best current alternative. This differential between the performance of the old and its alternative is called the "operating inferiority" of the existing machine.

If it did not cost us anything to replace machinery and equipment, we would naturally keep the "operating inferiority" to a minimum by frequent replacement. As we know only too well, new production facilities cost money. When the cost is taken into account, performance ceases to become the sole objective of replacement and we have to choose between more capital costs and less imperfection, or less capital cost and more imperfection. When we have such alternative magnitudes, each of which is adverse, we must find the proportion or combination of the two which minimizes their sum. This combination is the "adverse minimum." Applied to replacement analysis, it means, we should replace when the lowest combined average of operating inferiority and capital cost obtainable from the best new unit is below the lowest average obtainable from further use of the old machine.

Replacement decisions might be relatively simple if we had complete foreknowledge of all factors affecting them. Unfortunately, this cannot be and so to be practical we must make decisions without such foreknowledge. Any usable replacement formula must recognize this necessity, on account of which we have to develop two standard assumptions, one for the existing equipment and one for the proposed equipment to be designated hereafter as the "defender" and "challenger" respectively.

Unless we fix the future for the purpose of the analysis by projecting definite values for the variables involved, our problem is insoluble. A replacement analysis formula which does not clinch these variables by estimate or assumption can be woefully misleading. Such is the defect in the short-payoff or rate-of-return device. Assumptions as to future developments are completely hidden. You may argue that you know how to vary the payoff or rate-of-return requirement in line with your expectations, but you know neither the proper amount of the adjustment nor the point from which it should start.

It would be impractical to project specific estimates for each variable by any unit of time into the future. The problem has to be simplified. This is achieved through a standard pattern of assumptions as to the future. However, before proceeding to the formulation of these assumptions, it is necessary to understand the fundamental mechanics of the derivation of the adverse minimum by means of a simple example. Before proceeding, it must be recognized that the following computations for a detailed example of the theory are not necessary in individual analyses, the analyst being able to skip them entirely in favor of the simple chart solution which is presented following.

Let us consider a challenger that will carry no salvage value after installation and no capital additions after the original investment of $5,000. Its inferiority gradient is $100 per year. The inferiority gradient is the annual rate at which the operational gap widens between the machine in service and its best current alternative. The interest rate is 10 per cent. The successive steps in the calculation are given in Table I. Column 1 gives the width of the inferiority gap for each successive year of the present challenger's service life, assuming a gradient of $100 per year. Column 2 gives the factors for computing the present worths of the operating inferiorities in the first column, and in Column 3 the present worths for individual years. The individual worths are expressed cumulatively in Column 4. Column 5 gives "capital recovery factors" for various periods of time, which are applied to the present worths in Column 4 to yield the uniform annual equivalents, or time-adjusted averages in Column 6. These factors are then applied to the present worth of capital cost, $5,000, to

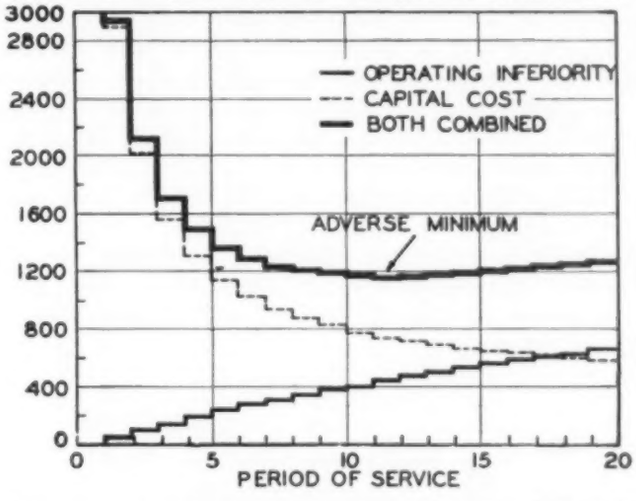


Figure 1 — Graphic representation of Columns 6, 7 and 8 in Table I (time—adjusted annual average for period ending with year indicated). Data from Dynamic Equipment Policy by George Terborgh, published by Machinery and Allied Products Institute.

yield the time-adjusted annual averages in Column 7. Finally, Column 8 displays the combined sum of the annual averages in the two columns preceding, the lowest obtainable being $1,173 for a 12-year period of service. This is the adverse minimum and is shown graphically in Figure 1.

The problem of replacement analysis is to compute the adverse minimum of the defender and the challenger, involving, in each case, separate projections into the future for inferiority, future obsolescence, and capital cost, from which the lowest available average of the two can be determined.

Operating inferiority is the margin by which the performance of a machine in service falls short of the performance obtainable from its best current alternative. It is the current operational gap between the two machines. In practice, this is measured on next year's operations.

The operating inferiority of the defender, in combination with its next-year capital cost, will be its adverse minimum when the combination is smaller than the lowest annual average of these two factors for any period of service longer than one year. Thus we have our first assumption, which is, that the defender's next-

year operating inferiority relative to the challenger will rise with time faster than the capital cost of keeping it in service will fall. This capital cost is the loss of disposal value during the year, plus a year's interest on the present value. Therefore, it follows that the sum of both factors for next year will be lower than the best average obtainable for any longer period, hence that this next-year sum is the adverse minimum itself. There are exceptions which call for special treatment, but our assumption is common in the practice of estimating "annual cost saving" on the basis of next year's operations alone, and it simplifies the problem with little risk of serious error.

One of the factors for which we must find a practical solution is the problem of prediction or, in other words, how can we satisfy ourselves that the selection we make for a replacement, that is, the "challenger," is not in itself going to be obsolete before our selection is justified. Assuming that at the time of decision the challenger has no inferiority, it will, if installed, acquire inferiority in the future as it deteriorates in service and as improved alternatives are developed. This inferiority must be measured, but since its rate of deterioration or obsolescence is not predictable, the best we can do is to make a standard projection which permits a simple calculation of average operating inferiority for any future period. This is accomplished by our second assumption, that "the challenger" will accumulate operating inferiority at a constant rate over its service life, and a secondary assumption that its salvage value will decline at a constant rate to the amount remaining at the end of the service life. Thus, by a single estimate, we can fix the future development of the challenger's operating inferiority and it becomes possible to determine the lowest annual average of inferiority and capital cost obtainable by the challenger, in other words its adverse minimum.

Through the adoption of the two foregoing standard assumptions, a formula for replacement analysis can be derived.

It will be realized from the foregoing that the derivation of the adverse minimum is too lengthy for practical use and, accordingly, short cuts must be developed.

Since it is impossible to obtain the uniform annual equivalent of operating inferiority for a given period of service without a cumulative calculation covering intervening years, there is no simple formula yielding the challenger's adverse minimum in one calculation. However, we can approximate the desired results non-cumulatively by substituting simple averages of operating inferiority and capital cost for the uniform annual equivalents theoretically prescribed.

Time does not permit an explanation here of the lengthy derivation of a formula for the challenger's adverse minimum. George Terborgh concluded in his studies of the problem that an approximate minimum could be reached directly in a single calculation. In the majority of cases, salvage values and prospective cap-

TABLE I

Derivation of Adverse Minimum of a Challenger Having a Cost of $5000 and an Inferiority Gradient of $100 a Year, Assuming No Capital Additions and No Salvage Value, With Interest at 10 Per Cent[a]

Year of service	Operating inferiority for year indicated	Present worth factor for year indicated[b]	Present worth of operating inferiority for year indicated (Col. 1 x Col. 2)	Present worth of operating inferiority for period ending with year indicated (Col. 3 cumulated)	Capital recovery factor for period ending with year indicated[c]	Time-adjusted annual average for period ending with year indicated		
						Operating inferiority (Col. 4 x Col. 5)	Capital cost ($5000 x Col. 5)	Both combined (Col 6 + Col. 7)
	1	2	3	4	5	6	7	8
1	$ 0	$0.909	$ 0	$ 0	$1.100	$ 0	$5,500	$5,500
2	100	0.826	83	83	0.576	48	2,881	2,929
3	200	0.751	150	233	0.402	94	2,011	2,104
4	300	0.683	205	438	0.315	138	1,577	1,716
5	400	0.621	248	686	0.264	181	1,319	1,500
6	500	0.565	282	968	0.230	222	1,148	1,371
7	600	0.513	308	1,276	0.205	262	1,027	1,289
8	700	0.467	327	1,603	0.187	300	937	1,238
9	800	0.424	339	1,942	0.174	337	868	1,205
10	900	0.386	347	2,289	0.163	373	814	1,186
11	1,000	0.351	351	2,640	0.154	406	770	1,176
12	1,100	0.319	351	2,990	0.147	439	734	1,173
13	1,200	0.290	348	3,338	0.141	470	704	1,174
14	1,300	0.263	342	3,680	0.136	500	679	1,178
15	1,400	0.239	335	4,015	0.131	528	657	1,185
16	1,500	0.218	327	4,342	0.128	555	639	1,194
17	1,600	0.198	317	4,658	0.125	581	623	1,204
18	1,700	0.180	306	4,964	0.122	605	610	1,215
19	1,800	0.164	294	5,258	0.120	629	598	1,226
20	1,900	0.149	283	5,541	0.117	651	587	1,238

[a]Operating inferiorities treated as year-end magnitudes. Figures do not always add exactly because of rounding.
[b]The factor gives the present worth of $1 payable at the end of the year indicated.
[c]The factor gives the annuity, payable (at the end of each year) over the period indicated, which has a present worth of $1.

ital additions with respect to the challenger are generally of little account so that a simple no-salvage formula can be used. The formula is as follows:

$$\text{Adverse minimum} = \sqrt{2\,cg} + \frac{ic - g}{2}$$

where c = the cost
g = the gradient
i = the interest rate (in decimals)

The acquisition cost being known and the interest rate fixed, the only factor to estimate is the inferiority gradient or the average annual rate at which the challenger will accumulate deterioration and obsolescence.

$$= 1{,}000 + 200 = 1{,}200$$

Here we obtain an adverse minimum of $1,200, as against the theoretically exact figure of $1,173 in Table I.

To further simplify analytical work on replacement problems, MAPI has gone a step further by developing a chart for the derivation of the challenger's adverse minimum. See Figure 2. This graphic solution is simple to use as we will demonstrate shortly. This substitute yields an approximation to the formula result, rather than an exact identity. It is so close, however, it can be considered for all practical purposes equivalent. The adverse minimum derivable from the chart is in fact

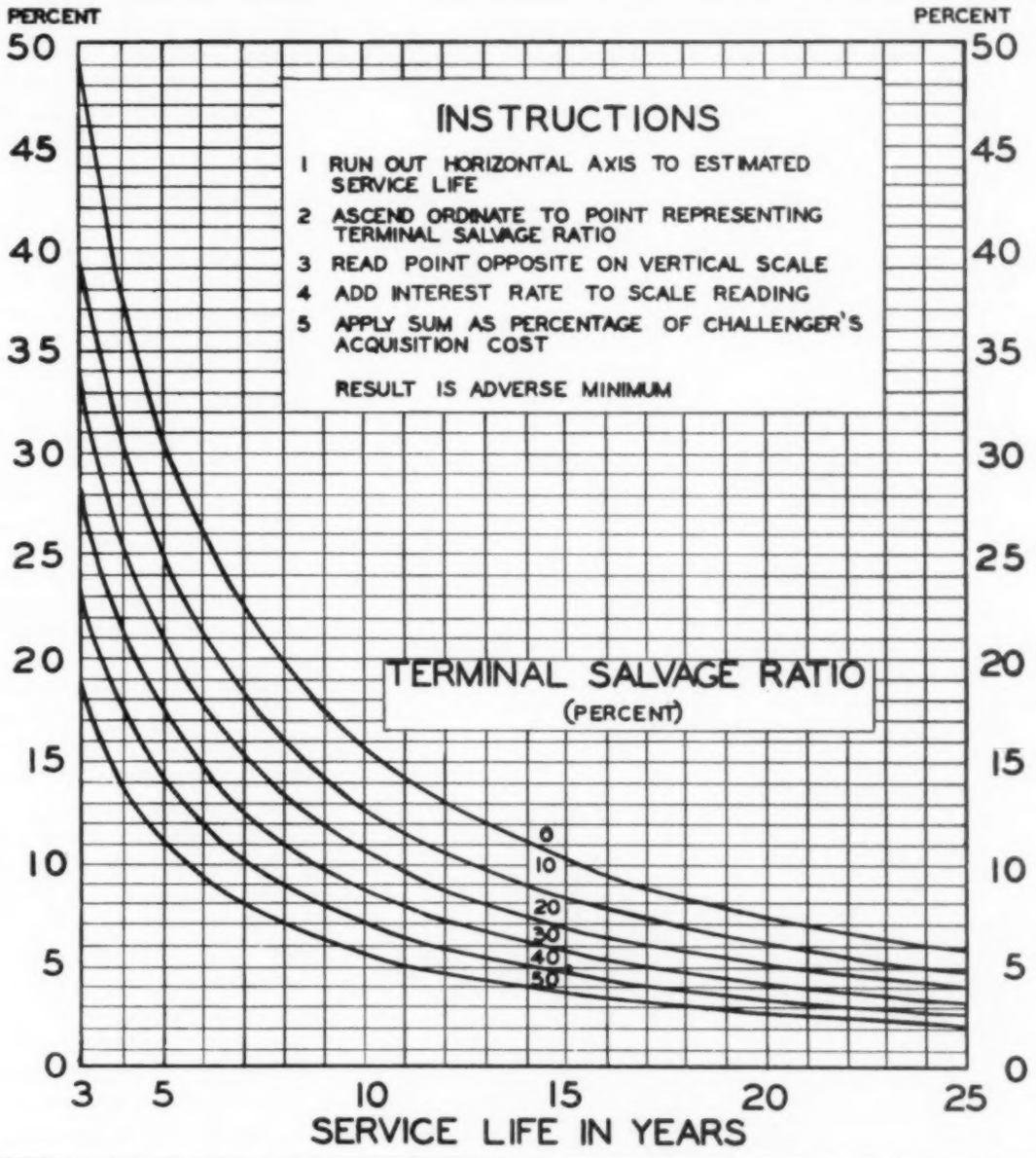


Figure 2 — Chart for deriving challenger's adverse minimum by the MAPI formula from "Company Procedural Manual on Equipment Analysis" published by Machinery and Allied Products Institute.

This formula approximates the correct adverse minimum so closely that the deviations are negligible. For example, if we apply the formula to the challenger in Table I, we then have:

$$\text{Adverse minimum} = \sqrt{2 \times 5{,}000 \times 100} + \frac{0.10\ (5{,}000) - 100}{2}$$

$$= \sqrt{1{,}000{,}000} + 200$$

within 5 per cent of the formula result over any ordinary range of cases and the deviations approach zero toward the center of the range. In an operation as rough-and-ready as replacement analysis must necessarily be, such errors are negligible.

ORGANIZATION

Before proceeding to the details of replacement analysis under the MAPI formula, let us consider first the

importance of proper organization. Regardless of what method of replacement analysis you may adopt, proper replacement policy cannot be achieved without good organization. The organization which will suit one company will not necessarily suit another. The size of the company, the character of its operations, the condition of its facilities, the personalities in management, etc., must be considered. However, the organization should be set up so that:

1. Replacement analysis is assigned to one or more specialists within the organization.
2. Replacement proposals are permitted to originate from operating personnel such as foremen, plant engineers and superintendents as well as from management and the replacement specialists.
3. The company's facilities are set up so that management knows at all times the opportunities for replacement.
4. The specialists should have access to appropriate records and, if necessary, institute records such as maintenance costs, production records and other related items.
5. Management can establish proper control of replacement policy. This is essential since financial consideration can be foremost in policy considerations. Control may be in the form of annual budgeting or periodic review of appropriation requests.
6. Management can have knowledge at all times of what it is costing the company *not* to take advantage of currently available replacement opportunities.

THE APPLICATION OF THE FORMULA

Certain factors must be considered in any proper replacement analysis. Those which will be stated here need not all apply to a particular replacement and analysts will recognize other factors not mentioned.

1. *Savings in direct labor.*
   The new machine or facility may produce savings in direct labor through:
   a. Faster speeds in the operation of a machine, mill or steel plant operation.
   b. Heavier cuts on a machine tool, the use of larger ingots, blooms or billets on a mill, or larger unit charges in a steel plant.
   c. Shorter set-up time on a machine tool or roll and guide changing time on a mill.
   d. Reduction in machine time or steel plant and mill operations through automatic features.
   e. Reduction in material handling time, direct or indirect.

   In steel mill equipment, savings may also be accomplished by the use of electronic devices, centralized controls and continuous production methods.

   In computing the direct labor costs, consideration should be taken of:
   a. Overtime.
   b. Incentives.
      A. Production bonus.
      B. Annual bonus.
      C. Profit sharing plans.
   c. Paid vacation.
   d. Social Security tax.
   e. Insurance, pensions and other company paid benefits.

   Since the above labor cost will vary from one employee to another, the analyst should multiply the hourly rate by an appropriate factor reflecting these costs.
2. *Savings in supervision and administration.*
   Savings in these costs will only be accomplished when they are eliminated as, for example, where continuous or centralized facilities are bought to replace older hand operated equipment or scattered operations. In single machine or production unit analyses, these costs can generally be excluded. Throughout this check list of operating costs there are many items included accounting-wise in overhead. Savings in indirect labor should not be assumed on the basis of application of overhead burden rates whether in ratio to direct labor or otherwise. Indirect labor savings which are actually realizable, such as in supervisory or administrative overheads, in inspection or in time or record keeping, etc., should be the subject of item-by-item estimates.
3. *Maintenance costs.*
   Only regular or recurring maintenance costs should be considered. The cost to rebuild should be taken into consideration whenever a rebuild job is being considered as an alternative to a new facility.
4. *Cost of supplies.*
   Two production units may require different supplies, e.g., with respect to machine tools high speed steel cutters cost less than carbide cutters. Different fixtures and attachments may be involved. Different qualities and quantities of fuels, raw materials, semi-finished materials, lubricants, coolants and hydraulic fluids may be necessary.
5. *Miscellaneous cost items.*
   Power—The annual difference in the cost of electricity, gas or air should be determined.
   Floor space—The new machine or facility may require more or less floor space than the old.
   Taxes—The new equipment will be subject to higher property taxes.
   Insurance—Differences in cost of annual fire and casualty insurance should be computed.
6. *Quality factors.*
   The new equipment may improve the quality of the product. It should, therefore, be credited with cost savings in subsequent operations, reduction in scrap, and reduction in inspection time.
7. *The capacity factor.*
   If the productive capacity of the new equipment is greater than the old, and if the difference is currently and prospectively usable, it should be taken into account in determining the old equipment's future operating inferiority.
8. *The salvage value of the old equipment.*
   An approximation of the salvage value of the old equipment can generally be obtained through secondhand or scrap dealers. However, if it is pro-

TABLE II

Equipment Replacement Analysis

Est. No. 0 — Date 3/12/52

Machine No.	Present		Proposed
1 — Description	36-in. vertical slotter	Description	48-in. vertical slotter
2 — Salvage value	$6000.00	Cost installed	$39,000.00
3 — Age	20 yrs.	Service Life	18 yrs.
4 — Equipment No.	552	Estimated salvage value	$6000.00
5 — Department	No. 14	Salvage ratio, per cent	.15
Adverse minima (Line 29)			
6 — Operating inferiority	$5,481.20	Total cost installed	$40,000.00
7 — Loss salvage value — Next year	700.00	Chart, per cent	6.4
8 — Interest — Salvage value	480.00	Interest, per cent	8
9 — Proration — Capital addition		Total, per cent	14.4
10 — Interest — Capital addition			
11 — Adverse minimum	$6,661.20(A)	Adverse minimum	$5,760.00(B)
12 — Gain from replacement (next year) — (A-B)	$901.20		

Operating Advantage (Next Year)

Income Advantages	Present		Proposed
13 — Superiority of product			$1 500.00
14 — Increased output			4,134.00
15 — Other			
Cost Advantages			
16 — Direct labor 52 x 100 x 0.12	$ [624.00		
17 — Indirect labor (Inspection and supervision)			125.00
18 — Fringe benefit costs — 20 per cent	124.80		25.00
19 — Maintenance			208.00
20 — Supplies	104.00		
21 — Tools			
22 — Spoilage			300.00
23 — Down time			312.00
24 — Floor space			
25 — Power	150.00		
26 — Property Taxes — Insurance	800.00		120.00
27 — Other — Per cent of work on planers			1,560.00
28 — Best suited for 48-in. slotter	$1,802.80(C)		$7,284.00(D)
29 — Net operating advantage (D-C)		$5,481.20	(to Line 6)

Remarks

Recommendations

Signed — Approved

Date — Date

posed to transfer the equipment from, say, one plant to another, it is not so easy to determine its salvage value. In this situation the analyst can at best "guesstimate" the value, which should not be less than the resale value, otherwise it would pay to sell rather than transfer.

Having considered factors involved in a replacement analysis and recognizing that others will become apparent in the light of specific cases, let us take two examples to illustrate the application of the formula, starting first with a simple machine tool replacement.

Problem 1: Replacement of a 20-year-old 36-in. vertical slotter with a new 48-in. machine. The complete analysis for this case is shown in Table II and the explanation of the various steps, where explanation is required, is given in Appendix I.

From the analysis in Table II, replacement is indicated in that the gain from replacement next year is $901.20. In other words, this is the amount it will cost the company next year not to replace now.

The second example is a hypothetical case involving more complex analysis, as would be the case in most steel plant problems. Nevertheless, it shows that essentially the same procedure is followed and that the derivation of the end result of the analysis gives a sound basis on which management can base a decision.

Problem 2: Replacement of a 28-year-old open hearth shop with a new electric furnace shop, both having the same nominal capacity of 250,000 tons per year. The complete analysis is shown in Table III and a detail of various steps which are not self-explanatory is given in Appendix II.

The analysis of the operational next-year advantages indicates that the defender has an operating inferiority of $961,000.

Estimating that the salvage value loss of the defender next year is $30,000 and that the loss of interest at 8 per cent on the immediate salvage value of the defender is $24,000, we have on addition to the defender's operating inferiority obtained an "Adverse Minimum" of $1,015,000.

On examination of the situation with respect to the challenger, we find that its estimated salvage value at the end of its primary service life is 7.4 per cent of its installed cost. This ratio in per cent together with its estimated service life of 25 years, gives us a reading

from the chart (Figure 2) of 5.0 per cent and, assuming an interest rate of 8 per cent, we have a total of 13.0 per cent. Thus, 13.0 per cent of the challenger's installed cost, or $877,500, is its "Adverse Minimum."

The difference in favor of the adverse minimum of the challenger as against that of the defender being $137,500, replacement is indicated.

In this analysis, on the assumption that the maximum production from the old and the new plant is 250,000 tons per year and, using the same factors as used in the analysis in Table III, it will be found that the next year gain from replacement is $135,000. While the gain in the latter case and that given in Table III may seem relatively small in view of the investment involved, nevertheless replacement is indicated. In the case of the challenger, if a better power rate than the 8 mills per kwh were obtainable, the gain would be greater.

DEPRECIATION

Some methods of replacement analysis, erroneously MAPI believes and we agree, charge the defender with the book value or unrecovered cost of the old facility. The MAPI method charges as a next-year cost of the defender the loss of salvage value which it is expected will be experienced, and without reference to the accrued depreciation or book value accounting-wise, which is irrelevant. There is sometimes disagreement on this point, usually because of confusion. However, replacement decisions should not be influenced by the book value or unrecovered cost of the old facility. The replacement of equipment having a substantial remaining book value is very often retarded without proper analysis of other factors which may give definite indications for replacement. Further, the respective depreciation policy may be improper on account of inadequate

TABLE III

Re-Equipment Analysis and Operational Comparison

(See Summarizing Report and Recommendations)

Work Sheet — (See reverse side for other calculations)

Dated 11/26/53
Number 000

Line		
1	Subject of analysis	Steel plant
2		
3		
4	Assumed rate of production	250,000 tons per year (nominal)

	A — Present Equipment — Defender		B — Proposed Equipment — Challenger	
5				
6A/B	Description: Three 150-ton open hearth furnaces — 260,000 tons per year		Description: Three 18-ft electric furnaces — 300,000 tons per year	
7	Date purchased	1925	Make and source	
8	Installed cost	$3,600,000	Installed cost	$6,750,000
9	Disposal: Scrap	Salvage or conversion value $300,000	Estimated primary service life: 25 yr	Estimated terminal salvage $500,000

	Operational next-year advantages (Differences)	A Defender		B Challenger	
		Total	Advantage	Total	Advantage
11					
12	"Cost above"	$ 3,890,000	$ 765,000	$ 4,455,000	
13	Property taxes and insurance	40,000	32,000	72,000	
14	Cost of metallics	12,428,000	802,000	13,230,000	
15	Increased output			2,560,000	$2,560,000
16					
17					
18					
19					
20					
21A/B	Totals	$	$1,599,000	$	$2,560,000
22	Defender operating inferiority	(Net challenger advantage) 21B-21A			$ 961,000

	A — Adverse minimum — Defender		B — Adverse minimum — Challenger	
23				
24	Operating inferiority (Line 22)	$ 961,000	Installed cost (Line 8B)	$6,750,000
25	Salvage value loss — Next year	$ 30,000	Primary service life (9B)	25 yr
26	Interest at 8 per cent (X Line 9A)	$ 24,000	Terminal salvage value (9B)	$ 500,000
27	Capital additions — Total $		Salvage per cent (26B of 24B)	7.4
28	Next-year proration	$ None	Chart, 5 per cent; Interest, 8 per cent — Total	13
29	Interest at 8 per cent (X Line 27A)	$	Total per cent X installed cost (28B X 24B)	$ 877,500
30	Total — Omitting Line 25 =		Annual average periodic capital additions	$ None
31	Adverse minimum	$1,015,000	Adverse minimum (29B + 30B)	$ 877,500

32	Next year gain from replacement (31A - 31B)	$137,500

writeoff or excessive service life. Depreciation policies also influence replacement by their control of capital and particularly on the timing of the availability of capital, which again creates a hesitation to replace equipment before the end of its estimated life. The Treasury Department's policy on depreciation, requiring a writeoff over twenty years or more, is a deterrent to investment, when in actuality many categories of equipment are obsolete on the average about every seven years. This policy, coupled with high corporate taxes on the profits from which equipment could be financed, is a serious deterent to replacement.

THE INTEREST RATE

One of the most important factors in replacement is "interest" or the cost of money. It is easy to recognize interest but more difficult to measure it. When money is borrowed from the outside, we know pretty well what the interest rate will be, but do we know the total cost? When we use the company's own funds, we may have a problem in determining the proper rate of interest, particularly where a long range program is under consideration. The time effect on interest rates must be considered.

In the case of borrowed capital, while we can readily establish the interest rate, we should not lose sight of a hidden cost in the form of the guarantee of security to the lender. The real cost of borrowed money can be well above its nominal cost. What this added cost is, each company must determine for itself, since it depends on the character of the business and its capital structure.

Where internal funds are used for a replacement, there is also a cost. We have to consider the loss of income through the non-investment of such funds. At best, this cost can only be determined by a rough estimate.

Whatever the case may be, the interest rate for replacement purposes should not be less than the cost of money or the return obtainable on outside investment. The decision to borrow or to use internal funds will depend on whether the company is on a capital surplus or capital deficit basis.

There are many ramifications of this problem which we are not qualified to discuss, but it bears close study by the replacement analyst.

SUMMARY

Replacement, its economics and problems, related to machinery or any other production facilities representing, as they do, a major investment item in manufacturing companies, should receive even more attention from management than is currently being given. Equipment must be kept in order if a company is to stay in business. The time to replace is when equipment can be replaced at a profit, regardless of age. If the current tax situation is such that you cannot replace all your obsolete machines, at least replace those you find can be replaced with the greatest return.

A sound replacement policy will not only strengthen the competitive position of a company, but will extend the benefits to its customers in the form of increased output and lower prices.

Most of us like to think our own organization gives proper consideration and study to our replacement problems. If so, let us test our convictions by asking ourselves these three questions:

1. Do we know the equipment in our plants that can be economically replaced?
2. Do we know what it is costing the company not to make the indicated replacements?
3. Is our organization properly set up so that top management is informed of replacement opportunities?

Without a good analytical technique for individual replacement situations, no amount of system and organization can produce satisfactory results. The adoption of a dynamic replacement policy by American industry will do much to insure the future of our country.

Finally, the author wishes to acknowledge the assistance given in the preparation of this paper by the Machinery and Allied Products Institute, with whom he has been privileged to participate in the study of this subject and for permission to incorporate material from their publications in this paper. Acknowledgement is also given Bituminous Coal Research, Inc., for permission to use published data for the hypothetical steel plant analysis.

BIBLIOGRAPHY

1. "*Dynamic Equipment Policy*"; "*MAPI Replacement Manual*"; "*Company Procedural Manual on Equipment Analysis*," published by Machinery and Allied Products Institute, 120 S. La Salle Street, Chicago, Ill.

2. "*Comparative Economics of Open-Hearth and Electric Furnaces for Production of Low-Carbon Steel*," published by Bituminous Coal Research, Inc., 2609 First National Bank Building, Pittsburgh 22, Pa.

APPENDIX I

Replacement of a 20 Year Old 36" Vertical Slotter with a New 48" Slotter (See Table II).

2 —Salvage value ($600.00)—the price at which it is estimated the present machine can be sold in the used machinery market.

3 —The service Life of the challenger (18 years) is its estimated useful life.

4 —Estimated salvage value ($6000.00) is the price anticipated on the used machinery market at the end of the challenger's service life.

5 —Salvage ratio (15 per cent) $= \frac{6000 \times 100r}{39{,}000} = 15.3$

6 —Operating inferiority ($5481.20)—see items 13 to 29 below. Total cost installed ($40,000.00). The analyst has added $1000.00 contingency to the estimated installed cost on line 2.

7. —Loss of salvage value—next year ($700.00). This is the expected run-off in salvage values—the difference between estimated salvage value of defender now and one year hence. Where values are relatively small, they influence the comparison but slightly and may be guessed, as has been done in this case. Chart per cent (6.4 per cent)—See Figure 2.

8 —Interest—salvage value ($480.00). The salvage or conversion value multiplied by the interest or required rate of return. In this case: $6000 x 0.08 = $480.00.

Interest per cent (8 per cent). The analyst's estimate of the cost of money. In this case the company's own funds are to be used for the purchase of the new machine.

9 —Total per cent (14.4 per cent). The sum of lines 7 and 8 above.

11A—Adverse minimum ($6661.20). The total of lines 6, 7 and 8 above.

11B—Adverse minimum ($5760.00) is

$$\frac{14.4 \times 40{,}000}{100} = \$5760.$$

12 —Gain from replacement (next year) or ($901.20) is the difference between 11A and 11B.

13 —Superiority of product. The analyst has estimated that the proposed new machine will give a better product than the old valued at $500.00 for the next year.

14 —Increased output. On the basis of operating 20 hours, 5 days per week for 52 weeks and with an increase of efficiency in the new machine over the old of 15 per cent,* the result will be time saved, which, multiplied by the operating cost of the machine ($5.30 per hour),** gives a credit to the new machine of $4134.00.

16 —Direct labor. The new machine was placed in a higher operating cost group. The differential between the group cost of the new machine and that of the old in this plant was 12 cents per hour. Thus 20 x 5 x 52 x 0.12=$624.00 and represents a credit to the old machine.

17 —Indirect labor ($125.00). This is the analyst's estimate of the costs to be saved by the new machine through less inspection and supervision time.

18 —Fringe benefit costs ($124.80). These costs are estimated to be 20 per cent of direct and indirect labor advantages, i.e., 20 per cent of lines 16 and 17.

19 —Maintenance ($208.00). The amount necessary to keep the old machine in operation over the new based on two hours per week for 52 weeks at a rate of $2.00 per hour.

20 —Supplies. The analyst has estimated that the cost of supplies for the new machine in excess of those required for the old is $104.00.

22 —Spoilage ($300.00). The amount estimated as a credit to the new machine as a result of 52 hours lost on the old machine due to errors multiplied by the hourly rate on the old machine.

23 —Down time ($312.00). Estimated on the basis of 52 hours lost on the old machine multiplied by the hourly rate on the old machine.

25 —Power ($150.00). Both old and new machines are equipped with 20-hp motors. The credit in favor of the present machine is the estimated cost of additional power to be used by the new machine in one year.

26 —Property taxes and insurance. Estimated at 2 per cent of the installed cost of the new machine and 2 per cent of the salvage value of the old.

27 —Other advantages ($1560.00). In this case certain work assigned to a planer can be done on the new slotter at a saving of $1560.00 per year.

29 —Net operating advantage ($5481.00). The difference between the total advantages for the present and proposed machines.

*Estimated on a basis of plant experience on similar tools.

**Standard cost rate based on normal production and includes estimated amounts for direct and indirect labor, maintenance, supplies and other services and fixed charges.

APPENDIX II***

Replacement of a 28-Year Old Open Hearth Shop with a New Electric Furnace Shop, Both Having the Same Nominal Capacity of 250,000 Tons Per Year (See Table III).

A —The present equipment comprises three 150-ton furnaces, cold charged. The hourly output of each furnace is about 12-tons. Assuming a furnace availability of 92 per cent and an ingot yield of 89 per cent, the annual ingot-producing capacity of the shop will approximate (12 x 24 x 365 x 0.92 x 0.89 x 3) or 260,000 tons. This plant was installed in 1925 and capital cost at that time was $3,600,000.00.

B —The proposed new equipment comprises three 18-foot furnaces, cold charged. The hourly output of each furnace is about 13.5 tons. Assuming a furnace availability of 95 per cent and an ingot yield of 91 per cent, the annual ingot-producing capacity of the shop will approximate (13.5 x 24 x 365 x 0.95 x 0.91 x 3) or 300,000 tons. The estimated capital cost of this plant is $6,750,000.00.

9A —The estimated salvage or scrap value of the existing open hearth shop is $300,000.00, being the difference between the salvage value of materials and demolition costs.

9B —The new electric furnace shop has an estimated service life of 25 years, at the end of which it will have an estimated salvage value of $500,000.00.

12A & B—The "cost above" for the old plant and the estimate for the new plant are based on the figures given in Tables IV and V on a basis of the defender producing 260,000 tons and the challenger 300,000 tons of ingots per year.

13A & B—Fixed charges comprising interest, taxes, amortization, etc., are assumed to be actual current charges in the case of the defender and estimated for the challenger on the basis of 12 per cent of total capitalization.

14A & B—The cost of metallics for the defender and challenger is based on the costs shown in

***The data used in this analysis is taken from "Comparative Economics of Open-Hearth and Electric Furnaces for Production of Low-Carbon Steel," Copyright 1953 by Bituminous Coal Research, Inc. Certain factors have been weighed to suit this hypothetical problem.

TABLE IV

"Cost Above" Per Ton of Ingots in Defending Open-Hearth Shop Using Cold-Metal Charge

1 — Fuel oil	$ 3.45
2 — Fluxes	0.70
3 — Furnace refractories	0.82
4 — Ladle refractories (ladle brick, sleeves, nozzles, etc.)	0.20
5 — Furnace repairs (masonry, labor, materials)	1.80
6 — Molds and stools, replacement and conditioning	1.20
7 — Production labor ($2.00 per man-hour)	2.20
8 — Maintenance labor and materials	1.15
9 — Oxygen	—
10 — Supplies, tools, lubricants, etc	0.40
11 — Water, steam, electric power, etc.	0.40
12 — Yard switching	0.70
13 — Slab disposal	0.45
14 — Indirect labor (supervision, chemical, metallurgical, clerical)	0.32
15 — Employee benefits	0.37
16 — General expense (overhead)	0.80
	$14.96

TABLE V

Estimated "Cost Above" Per Ton of Ingots for Challenging Electric Furnace Shop Using Cold-Metal Charge

1 — Power (8 mills) 525 kwhr	$ 4.20
2 — Electrodes ($0.18) 12 lb	2.15
3 — Fluxes	0.62
4 — Furnace refractories	0.60
5 — Ladle refractories (ladle brick, sleeves, nozzles, etc.)	0.15
6 — Molds and stools, replacement and conditioning	0.85
7 — Furnace repairs (masonry, labor, materials)	1.20
8 — Production labor ($2.00 per man-hour)	1.70
9 — Maintenance, labor and materials	0.95
10 — Indirect labor (supervision, chemical, metallurgical, clerical)	0.35
11 — Oxygen and compressed air	0.28
12 — Supplies, tools, lubricants, etc	0.20
13 — Water and utilities	0.35
14 — Yard switching	0.25
15 — Slag disposal	0.20
16 — Employee benefits	0.30
17 — General expense (overhead)	0.50
	$14.85

Table VI, producing 260,000 tons and 300,000 tons respectively.

15B —Since the challenger has a greater annual production than the defender by 40,000 tons at an estimated sales price of $64 per ton, the challenger can be credited with an advantage of $2,560,000.00 per year.

DISCUSSION

PRESENTED BY

CHARLES H. GOOD, JR., Assistant to General Superintendent, United States Steel Corp., Duquesne, Pa.

G. G. BEARD, President and General Manager, United Engineering and Foundry Co., Pittsburgh, Pa.

K. J. DOLL, Superintendent of Service Shop, General Electric Co., Pittsburgh, Pa.

Charles H. Good, Jr.: Mr. Beard has presented an interesting formula which represents a constructive approach to the problem of evaluating equipment replacement. Whether we use this, or some other formula for evaluation, the most important step is that we group *all* of our investment possibilities and then, on a uniform basis, apply a formula which represents a sound, businesslike approach to the problem.

We are sometimes prone to separate our investment possibilities into two categories; those that we say are necessary to maintain operations and those that are desirable to increase profit or production. By this method of grouping, emphasis is placed on the so-called necessary projects and, in many instances, the available investment funds are allocated entirely to such projects.

I believe that we, as operators and engineers should orient our thinking to the basis that it is very seldom necessary to completely replace a piece of equipment; it can usually be maintained—at a given cost. If such reasoning is applied, the replacement project can be evaluated on a sound financial basis and compared with other investment possibilities to obtain the most value from available investment funds.

G. G. Beard: I want to thank Mr. Good for pointing out something that is very pertinent, and he is absolutely correct in what he said. First of all, we have to get our replacement thoughts channeled in the proper direction. We have to consider all of the possibilities within our plant for replacement, not just one particular item picked out indiscriminately.

Mr. Good also said, if you will note, that we can maintain equipment, at a price. That statement he made is absolutely correct too. The price that you are going to pay to maintain it next year will be shown in this analysis. In fact, the differential between the two ad-

TABLE VI

Cost of Metallics Per Ton of Ingots in Open-Hearth and Electric-Furnace Shops of 250,000-Ton Nominal Annual Ingot Capacity Cold Charge

	Open hearth		Electric furnace	
	Pounds per ton of ingots	Cost	Pounds per ton of ingots	Cost
Steel scrap at $43 per gross ton	1,668	$32.00	1,985	$38.10
Pig iron at $58 per gross ton	556	14.45	173	4.50
Iron ore (lump) at $14 per gross ton	24	0.15	50	0.30
80 per cent ferromanganese at $225 per gross ton	12	1.20	12	1.20
Total cost of metallics		$47.80		$44.10

verse minimums, as I pointed out, is the price that you are going to pay for maintaining the old equipment next year over the cost of replacing it.

Member: In one of the curves you had a capital cost figure coming down, which was not a straight line, how did you attain that?

G. G. Beard: The reason for that is the curves are derived from an algebraic formula, which is not a straight line function.

Member: You said capital cost. Was that a book value? Is there any way of determining that? I do not see how that can be done easily, and by book value it would be a straight line.

G. G. Beard: That is correct. The first curve you saw, where the capital cost was not the straight line, is a theoretically correct reduction of the capital cost for each year of service and you can see how that is computed if you will follow the table in the paper. It is not a straight line, but in the formula we have to make an assumption, we cannot go through the lengthy calculation of determining what the reduction in capital cost is going to be each year, otherwise we would never be done with our analysis. So we made our assumption.

I said we have to make two assumptions. The second assumption we made resulted in a straight line projection. Theoretically that assumption is not correct, I will not claim it is. You will find that the margin of error in making that assumption is very small and in most calculations it is within five per cent. You may think that five per cent is a large margin of error, but in any replacement analysis, with all the various factors and all the assumptions you have to take into account, if you are not out more than five per cent you are doing a pretty good job, in my estimation.

K. J. Doll: I would like to ask Mr. Beard if this formula could be applied to large electric drives and turbine generators.

In this type of equipment the average maintenance cost is low, the output is not effected by age, there is little wear and deterioration. Unless a failure occurs, it is sudden and exceedingly costly.

The real problem exists in evaluating the time of failure expectance on all large electric equipment. It would be a wild guess and your formula could therefore not very well be applied in this case.

G. G. Beard: I agree that the relatively small amount of deterioration involved over a considerable period of time on certain types of electrical equipment makes application of the MAPI formula questionable in their case.

Member: What is the gradient? I am just not quite clear on the "g" in that formula.

G. G. Beard: The "g" factor in the formula is the value of the deterioration, the amount in dollars that the facility or unit will lose through continuance of its operation for one more year.

Orders Are Now Being Taken for

Tube Mill Practice

A selection of articles from the IRON AND STEEL ENGINEER on various phases of tube making.

Practical information on layout and operation of facilities for seamless, butt and electric weld pipe, a field in which little information has been published ... 23 articles by 20 authoritative writers ... invaluable for engineers, operators, trainees and students.

8-¼ x 11-¼ in.,.....196 pages, illustrated, clothbound

Price: To AISE Members...$2.00

To Others.....$4.00

ASSOCIATION OF IRON AND STEEL ENGINEERS

1010 Empire Building

Pittsburgh (22), Pa.

Pumpability of Steel Mill Greases

. . . . testing unit described checks pumpability of grease quite readily . . . .

PART I

By J. S. AARONS
Lubrication Chemist
National Tube Div.
United States Steel Corp.
Pittsburgh, Pa.

▲ THE importance of lubricants in the field of preventive maintenance is attracting greater and greater interest. There can be no argument put forth against the statement that satisfactory and efficient operation of a machine depends upon a material which will overcome the friction of that machine's moving parts. This material is the lubricant whether it be an oil or a grease. With this realization in mind, steps have been taken to improve lubricant application and slowly but surely the battered bucket and stick have been replaced by centralized pressure lubrication.

Centralized lubrication has brought untold blessings to machine operation. The dangerous condition of greasy and oily floors, the elimination for the most part of the human element in lubricating each bearing, and the savings effected in the more economical use of a lubricant are only a few of its advantages. But in order to further the use of these new methods of lubrication, the laboratory has been called upon to develop methods that would assist in picking out the proper greases, not only for the machine itself, but also materials that would show good pumpability or mobility characteristics for the centralized system under low temperature conditions. Dependent upon location, mill temperatures are a very critical factor in determining the dispensing characteristics of greases.

In the type of service involved at the time the compression grease cup was developed, calcium soap cup greases of a No. 1 or No. 2 consistency were most widely used. In those days machinery so lubricated was subjected to less severe service than prevails today and rode largely on friction type sleeve bearings. Today, with the adoption of smaller bearing clearances and the perfection of high pressure units and centralized pressure greasing systems involving long lines, the flow characteristics of greases are becoming increasingly important.

Pumpability or mobility is that property which indicates how readily a grease can be moved in a lubricating system over a given temperature range.

In order to evaluate the mobility of greases there have been developed methods which have quite successfully determined this property. Unfortunately they are not practical in the limited space available to the small lubricants testing laboratory. A standard method of test has been adopted by the American Society for Testing Materials. This method is called Apparent Viscosity of Lubricating Greases. The test describes a procedure for measuring in poises the apparent viscosity of lubricating greases at room temperature.

A poise is the unit of absolute viscosity and is equal to one dyne second per square centimeter.

Apparent viscosity is the ratio of shear stress to shear rate.

Shear rate is the rate at which a series of adjacent layers of grease move with respect to each other.

Shear stress is the minimum force required to produce flow.

Lubricating oils are classed as true liquids at temperatures sufficiently above their pour points. Their viscosity or resistance to flow remains constant over a wide range of shear conditions for a given temperature. On the other hand, lubricating greases are oils thickened with soap and/or other solid materials to a plastic or semi-solid consistency. Their flow properties differ from those of oils in that the viscosity at a given temperature increases with decreasing shear rates. Therefore, greases are pseudo liquids and their resistance to shear under the conditions of any specific test is called the *apparent viscosity.*

The equipment used in making the determination of apparent viscosity is often called the pressure viscosimeter. The pressure viscosimeter apparatus consists of the following measure parts:

1. The power system — consisting of a one-third hp 1750-rpm induction motor coupled to a 200 to 1 speed reducer. Interchangeable 40 and 64 tooth gears are used to drive the hydraulic pump.

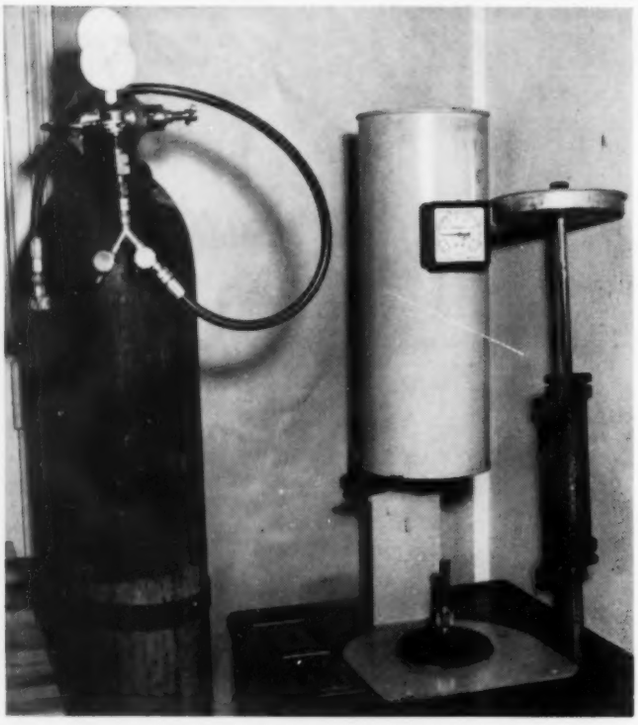


Figure 1 — Pressure is obtained from a tank of nitrogen gas.

2. The hydraulic system — a gear and a hydraulic oil reservoir having a capacity at least equal to the grease cylinder.
3. Gages.
4. The grease cylinder assembly — consisting of the cylinder and the floating piston and caps, with the piston moving the entire length of the cylinder without appreciable friction.
5. Capillaries — eight tubes of stainless steel, each of whose length is 40 times the actual orifice diameter. These diameters vary from 0.018 to 0.15 in.

Some laboratories have added refrigeration to study apparent viscosity of the lubricants at low temperatures. In this method the sample of grease is forced through a capillary by means of a floating piston actuated by an hydraulic system. From the predetermined flow rate and force developed in the system the apparent viscosity is calculated by means of Poisseuille's equation. A series of eight capillaries and two pump speeds are used to determine the apparent viscosity at 16 shear rates. A series of calibrated tests must be performed in order to standardize the hydraulic system and each capillary tube must also be calibrated.

The interpretation of results taken from the apparent viscosity determination of lubricating greases is not an easy task. In the hands of an experienced research worker it makes a very fine tool for the study of grease mobility but the data are too involved and much time is consumed in gaining the information. The reporting of so many poises at so many reciprocal seconds to the lubrication engineer will give rise to one question, "What do I do now?" The lubrication engineer demands a test that will give him a "go, no-go" answer on the grease in question and a test that will conform in its general outline to the conditions under which the material is being subjected.

Another method of test has been developed and studied for some time. This is the pumpability rate study using the air operated grease pumps. These pumps are of the high pressure service station type fitted with five feet or more of ¼-in. inside diameter hose and a central valve. These pumps are designed to pump from 100-lb cartridges. Where information is desired at low temperatures, a cold room is used. It was found that approximately 24 hours was needed as a soaking period for a 35 to 40 lb sample of grease to assume the required test temperature. The tests are performed with 125 psi air pressure to the pump. The length of time and the amount of grease delivered for a number of complete

Figure 2 — Cooling system can lower coil temperature to —36 F.

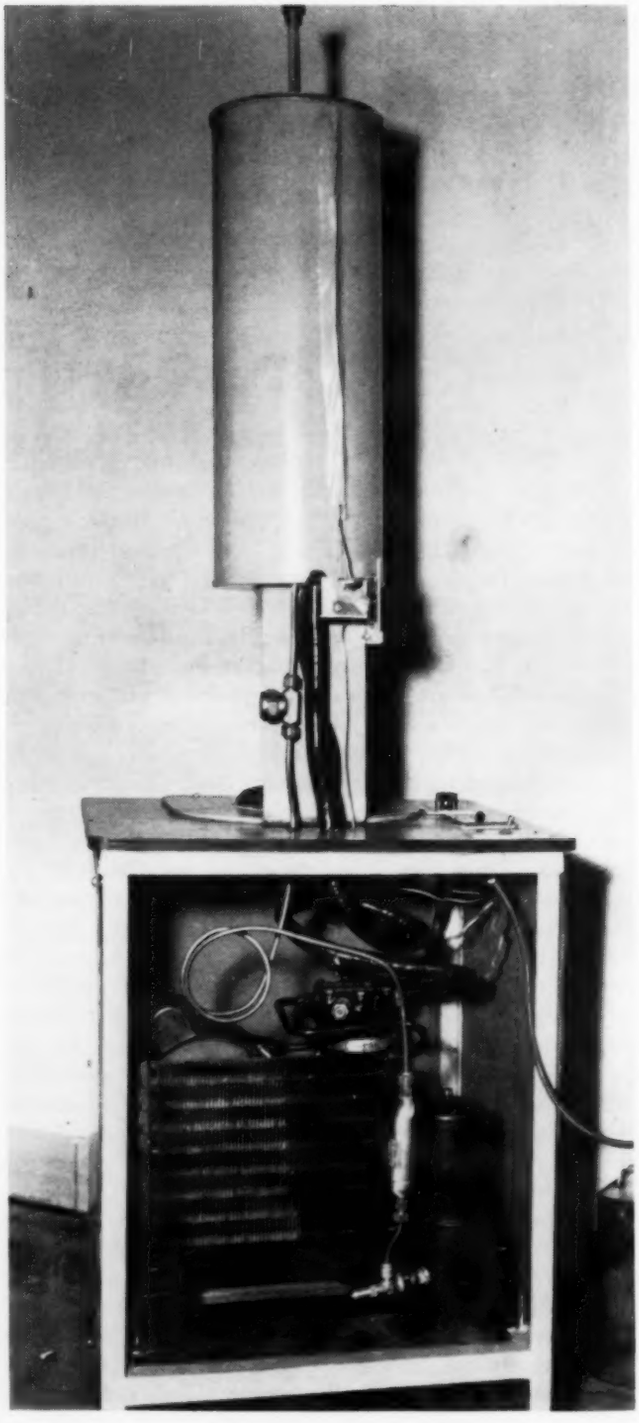


Figure 3 — Frost on cooling coils can be seen in this view.

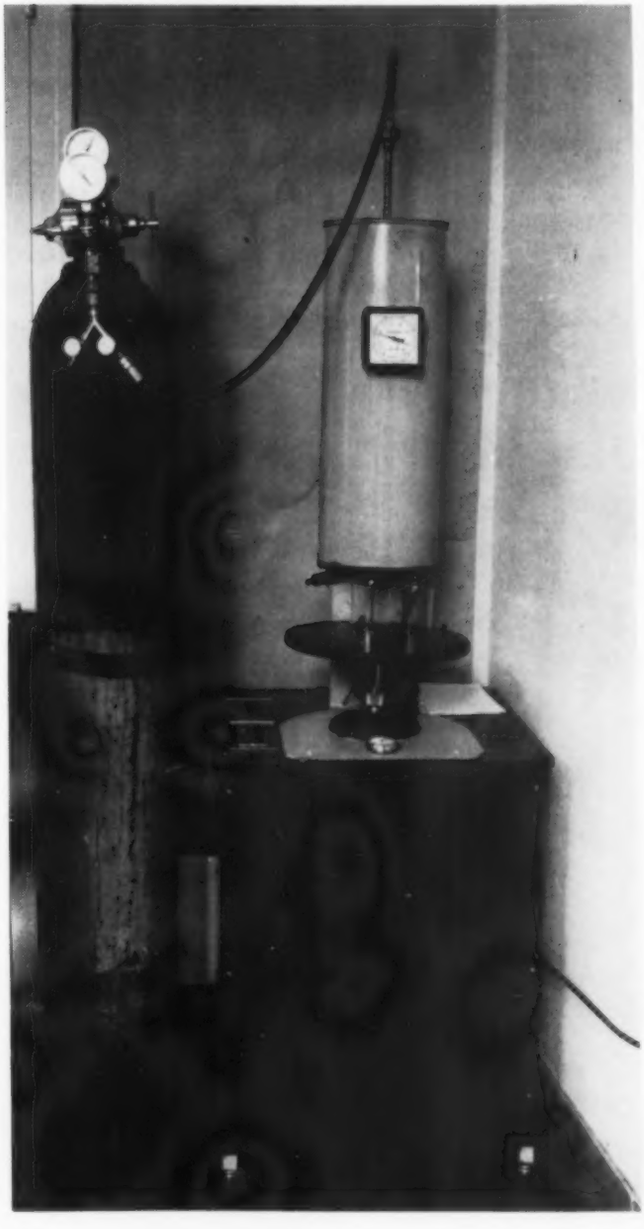
cycles of the pump are then measured. Satisfactory correlation between these results and apparent viscosity determinations have been claimed. The size of the equipment, the need for a cold room, and the excessively large samples required for a successful test run have limited the test's utility as concerns small laboratory use.

For these reasons there was a need for a small compact machine needing no more than four sq ft of space and incorporating into it some of the features of both machines just described and featuring a test that could be completed in less than four hours. This machine with less than one year of background information developed shows promise in helping the lubrication engineer in his selection of greases where low temperature pumpability is a critical factor. In the ASTM method for apparent viscosity, the pressure required to move the grease through each of the capillaries is used for determining shear rate. In the grease mobility machine the pressure is kept at a constant rate and the amount of grease extruded, in a selected time interval through a single standard capillary at the required temperature, is reported in grams per second. No attempt has been made to correlate the results with apparent viscosity results and all figures gained through the use of this machine have been made only on a comparative basis.

The machine consists of the following parts:

1. The grease pressure cylinder which has been taken from the pressure viscosimeter. Included in this part is the floating piston, the top and bottom caps, and the No. 1 — 40 to 1 ratio capillary tube. The hole accommodating the thermocouple lead in the bottom cap has been securely plugged off. A 12-in. piece of ¼-in. inside diameter pipe with a union is attached to the top cap. See Figure 1.
2. A pressure system comprised of a tank of nitrogen gas delivered from a 2400-psi pressure tank through a pressure regulating gage which reduces the effective pressure as desired. This gage is so constructed that any pressure up to 250 psi can be maintained constantly. See Figure 1.
3. A cooling system consisting of a compressor powered by a ¼-hp motor, an enclosed cylinder of refrigeration coils containing No. 12 freon as a refrigerant and with sufficient capacity to lower the coil temperature to minus 36 F. See Figures 2 and 3.
4. A measuring unit consisting of an adjustable turntable having two recesses to accommodate two 250-ml beakers, one recess being ⅛-in. deeper than the other. See Figure 4.

Figure 4 — Two beakers are mounted on an adjustable turntable under the cylinder.



5. A thermometer with a shaft diameter of 0.142 in and calibrated to minus 40 F. A mirror is used for facilitating in taking temperature readings. See Figures 5 and 6.

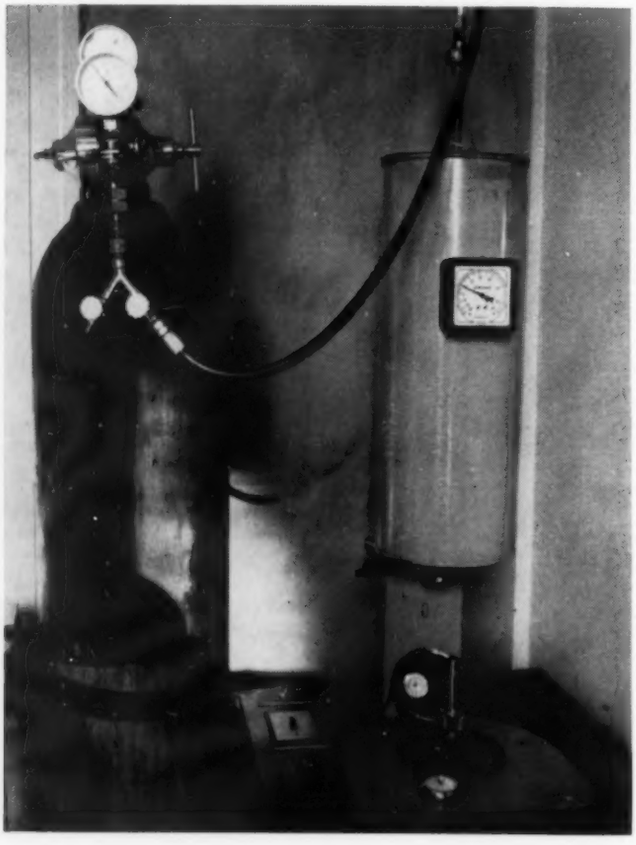
PROCEDURE

The sample of grease, approximately one pound, is placed in the pressure cylinder with the aid of a grease gun filler, care being taken to eliminate air pockets trapped in the cylinder. The floating piston is then placed in the cylinder and the capillary is screwed tightly to the bottom cap. At this laboratory, the tests are usually begun in the morning and therefore the cylinders are filled the previous afternoon and placed in a refrigerator overnight; this lowers the temperature of the grease to approximately 40 F. At the start of the test, the cooling system is turned on and the grease cylinder is placed into the cooling compartment. A series of four 250-ml beakers are tared and marked to correspond to the test temperatures; namely, 32, 20, 10, and 0 F. In some cases, where required, a lower temperature of minus 10 F is also used.

The thermometer is inserted through the orifice of the capillary tube. The thermometer face rests against the bottom of the capillary tube and the shaft end extends up into the grease sample for 1¾ in. The mirror is adjusted so that readings can be easily made. The nitrogen tank is then connected to the cylinder top.

When the temperature reaches 32 F, the thermometer is removed and the adjustable turntable is set in place with two beakers — one a waste beaker, and the other the 32 F tare beaker so placed that the waste beaker is

Figure 5 — A mirror is used to help in taking temperature readings.



⅛ in. higher than the tare beaker and flush with the bottom of the capillary tube. The reason for this is that the lift of the waste beaker becomes an effective knife edge and cuts the grease string cleanly before and after each time measured run. With the waste beaker in position the pressure is adjusted to 150 psi and when the extruded grease touches the bottom of the waste beaker, the platform is turned to set the tared beaker

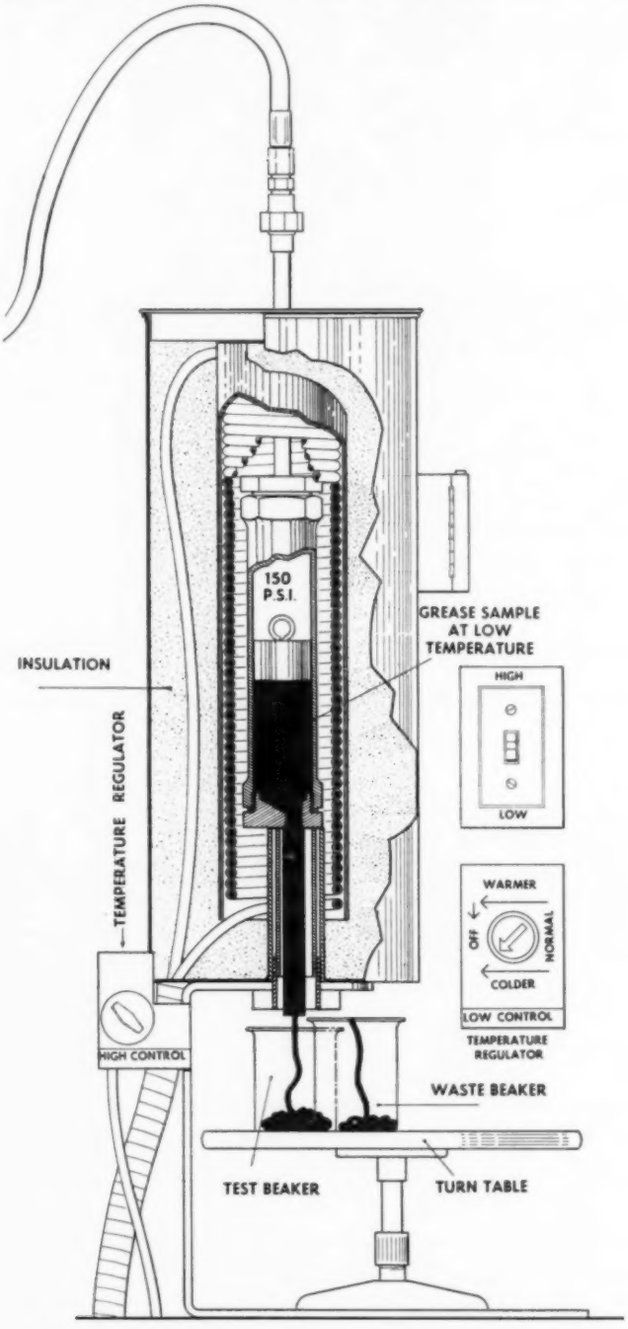


Figure 6 — Cross section shows details of unit.

in place, a stopwatch is started, and a 30 or 60-second run is made. It will be at the discretion of the operator to decide the length of time for each determination. Since pumpability rates of some greases are very high, 15-second runs are sometimes made. After completion of the run, the turntable is moved once more so that the waste beaker is in place, the pressure is released, the system is vented, and the cooling system is turned on for the next lower temperature run. It has been

TABLE I

	Base oil viscosity at 210 F, sec	Worked consistency at 77 F	Grease mobility in grams flow per second			
			32 F	20 F	10 F	0 F
High temperature, anhydrous calcium base, water-proof grease	65.0	315	0.501	0.180	0.063	0.022
	65.0	370	2.685	1.209	0.566	0.142
Steel mill roll neck grease with graphite filler	150.0	350	0.103	0.040	0.017	Nil
	80.0	340	1.127	0.524	0.204	0.11
	81.0	350	0.307	0.115	0.039	0.015
High temperature lithium base grease	64.0	302	1.57	0.59	0.24	0.156
	56.0	304	1.455	0.524	0.21	0.094
High temperature lithium base grease plus extreme pressure agent	75.0	340	0.287	0.100	0.034	0.015
	70.0	318	0.304	0.124	0.050	0.022

established that the cooling rate approaches approximately 1 F drop per 4–6 minutes. To insure a stable temperature at the prescribed test points the cooling system is turned off at 2 F above the test temperatures.

Some typical results are given in Table I.

No analogy has been drawn between the apparent viscosity determination and the grease mobility test. The use of a constant non-pulsating pressure and the disregarding of the initial pressure at the moment of grease movement rules out this approach. However, there is a definite analogy between the air operated pump and the grease mobility test. A scaled down model of the air pump's features has been successfully made and can meet the requirements of a small laboratory operation. Reproduction of results on this machine using the same operator has been good. Spot checking of samples has shown a repeatability of 85-90 per cent. The most important phase of the test, that being the correlation of results with actual field practice, is discussed in Part II.

PART II

By R. G. WARREN

Assistant Superintendent

Yard and Transportation

United States Steel Corp.

Edgar Thomson Works

Pittsburgh, Pa.

Before devising this testing procedure, we had no rapid control method determining the mobility of a new grease under the different operating temperatures encountered in the steel mill.

Many operators have been confronted at one time or another with the problem of pumping grease through a centralized system. In order to clarify the method of procedure you might use to determine if a grease is suitable for pumping through a centralized grease system, let us briefly consider an actual case. A grease was offered to us which would reduce our cost of lubricant per ton by over 25 per cent. After extensive laboratory tests, we began to use it in the summer and fall. It was a No. 1 grade grease with an ASTM cone penetration of 320; and its performance, including pumpability, was satisfactory. As was our policy, we requested a No. 0 grade with an ASTM cone penetration of 360 for winter use commencing October 1. Unfortunately, no sooner had the No. 0 grade been used on the mill involved when we ran into high pressures on the centralized systems which were supplying the grease to the bearings. We had been operating at approximately 2200 psi when we changed to the No. 0 grade. An early check indicated that something was definitely wrong, and it was not the centralized system. A quick trip to the laboratory with a sample of each of the greases indicated the trouble. The first two columns of Table I give the results of the laboratory mobility tests on the No. 0 and No. 1 grades of the new grease.

The company supplying the grease was notified, and they sent their grease laboratory representative to discus the matter with us. At first the representative felt we must be wrong in our observations, since at room temperature, the No. 0 grade had the consistency of soft butter on a warm day while the No. 1 grade was firm. We then repeated the mobility tests at the several low temperature levels and confirmed our original results.

A hurried test on the grease we had been using successfully for many years was rather startling. Note the difference in the last column of Table I.

TABLE I

Temperature, F	New grease		Former grease
	No. 0 NLGI 360 penetration, gm/sec	No. 1 NLGI 320 penetration, gm/sec	No. 1 NLGI 325 penetration, gm/sec
32	0.103	0.151	1.292
20	0.040	0.067	0.556
10	0.017	0.048	0.294
0	.....	0.010	0.100

Obviously we had to improve the pumpability characteristics of the new grease if we were to be able to use it successfully in our systems in cold weather.

A few days later the supplier sent a sample of a modified grease for checking mobility.

We were still not satisfied so we requested them to try again. As a result, they submitted a sample of a second modification of the grease and the mobility tests of the two modifications are given in Table II.

TABLE II

Temperature	New grease		First modification	Second modification	Former grease
	No. 0 NLGI 360 penetration, gm/sec	No. 1 NLGI 320 penetration, gm/sec		No. 1 NLGI 325 penetration, gm/sec	No. 1 NLGI 325 penetration, gm/sec
32	0.103	0.151	0.663	1.127	1.292
20	0.040	0.067	0.245	0.524	0.556
10	0.017	0.048	0.134	0.204	0.294
0	....	0.010	0.036	0.109	0.100

As you can see, we felt justified in giving the supplier the go ahead to make up a batch of the second modification grease for trial. It is not to be forgotton that the final grease submitted had to meet all our other standards set up for that particular type of grease in addition to being easily pumped. On putting the second modification grease on the mill, the pressure dropped back to 1650 psi.

Summarizing in brief, we are operating at 2200 psi with a No. 1 grade grease. Upon changing the grease to No. 0 grade, we had to increase the pressure to 2700 psi. Finally, we tailored-made a grease with the same pumpability characteristics as the one we had used for several years and the pressure dropped to 1650 psi. The chief modification made in the grease within a given grade was changing the viscosity of the oil. Our experience confirms the fact that, at lower temperatures, the pumpability of a grease depends more upon the viscosity of the oil it contains than upon the NLGI consistency of the grease.

There has been some criticism that perhaps we are tailoring our greases to fit the system while the important thing is to make a grease to lubricate the mills. We would be the first to agree that it is important to use a grease that will properly lubricate the mill. However, it is the job of the lubrication engineer to try first to obtain a grease suitable for the job that will work satisfactorily in the systems as they are, since it costs money to change systems. It would certainly be unwise to use a grease of inferior performance, however, due to any possible limitations of a particular method of applying the grease.

In conclusion, we might say that even though the grease submitted to any company was the best grease that it is possible to make and were given to us free of charge, it is of absolutely no value unless it can be pumped under the lowest temperature conditions you may encounter.

DISCUSSION

PRESENTED BY

J. S. AARONS, Lubrication Chemist, National Tube Division, United States Steel Corp., Pittsburgh, Pa.

Member: I believe the speaker mentioned they were using a 40 to 1 length diameter ratio. I wanted to ask if they have experimented anything higher than that, say, 80 to 1 or 100 to 1, or possibly more and how was the figure 40 to 1 selected? I understand tests have been run on standard pumping, trying to correlate results with the standards of the viscosimeter results. I was wondering how those results are correlated.

J. S. Aarons: The reason we use the number 40 to 1 ratio capillary tube is because it was the largest capillary that was available to us. Since it is 0.15-in., we could not at the time think of getting anything larger, so we settled for that. As I say, we have incorporated some of the equipment from the viscosimeter along with the idea of an air operated gun.

As far as the other question that you bring up, we ourselves have not done any actual correlation. My mention of that in my paper was only made after reading results from other laboratories using the air-operated gun.

Member: For some time now, we have used the test. It is the same in principle, but with slight modification in equipment and procedure. We have found that the reproduction of the test result has been sufficiently good to make the test worthwhile. We feel that the test has been a wonderful aid in predicting pumpability characteristics of a grease as related to a centralized lubricating system.

WANTED!

There is a constant demand for copies of "The Modern Strip Mill," published by the Association of Iron and Steel Engineers. If your copy is not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

ACTIVATED ALUMINA
for the maintenance of
Gas Engine Crankcase Oils

By DR. L. B. SARGENT, JR.
Assistant Chief, Lubricants Div.
and
DR. E. M. KIPP
Chief, Lubricants Div.
Aluminum Research Laboratories
Aluminum Co. of America
New Kensington, Pa.

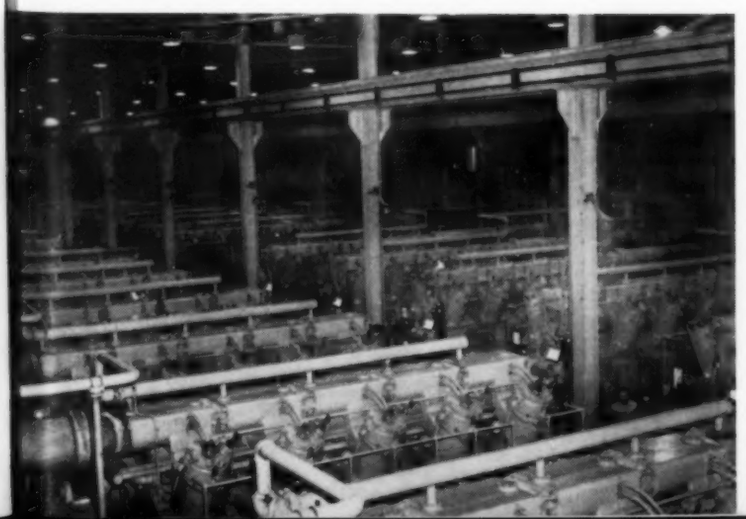
. . . . activated aluminas have shown unusually promising results in the test program covered by this paper . . . .

▲ THE operation of an aluminum reduction works near Hot Springs, Ark., during World War II involved a pioneering engineering project in that vast quantities of electric power were generated by means of a large number of gas-burning internal combustion engines. The necessity for continuous operation emphasized the maintenance of all equipment, particularly the engines. The power house had a potential of about 123,000 hp and consisted of 68 engines, each of 1165 or 3600 hp depending upon the type. As a part of this operation, the maintenance of the crankcase lubricating oil was an important economic and operational factor.

The many years of successful field use of activated alumina in the continuous maintenance of insulating oils, and the results of laboratory scale tests with motor oils, indicated that one or more of the various types of activated alumina might prove of value in the operation and maintenance of the crankcase lubricating oils for this installation.

Before undertaking a detailed investigation of the various grades of alumina for this application, the determination of the relative oil-maintenance effectiveness of a few selected grades of alumina and other granular inorganic absorbents was made on a limited basis.

Figure 1 — Seventeen 1165-hp, 10-cylinder, spark-ignited engines using natural gas were used in the test program.



The use of alumina for maintenance of gas engine oils was relatively new at the time.

ENGINES

The investigations utilized seventeen spark-ignited engines burning natural gas as fuel (Figure 1). The engines were Model GMV, 10-cylinder, 1165-hp, vee-type operating at a nominal speed of 350 rpm on a two-stroke cycle. Each crankcase had a lubricating oil capacity of 350 gallons. The oil make-up per crankcase was approximately 10 gallons per day and was primarily due to scavenging exhaust losses.

The lubricant used in all tests was a solvent refined straight naphthenic base oil with specifications listed in Table I. This oil contained no inhibitors, detergents or other additives and provided highly satisfactory performance in these engines.

TABLE I

Physical Properties of Crankcase Oil

Specific gravity	25.5 deg API
Viscosity	745-775 SSU/100 F
	63-72 SSU/210 F
Flash	445 F
Fire	515 F
Pour point	—5 F
Carbon residue	0.07 (max)
Neutralization number	0.01 (max)

FILTER MATERIALS

The materials listed in Table II were investigated as filtering and maintenance media for the crankcase oil on a by-pass continuous system.

Materials 1 and 2 in Table II were processed by us and the others were purchased from suppliers. The granular media were contained in a well known and widely used commercial unit. The filter bags of these units were hand filled. The block-type materials were likewise placed in the filter cases by hand at the plant site.

EXPERIMENTAL PROCEDURE

The filters operated as by-pass units on a continuous basis; i.e., oil flowed from the crankcase through the units whenever the engine was operating. Because of this arrangement, the oil was being filtered continuously while being used. The filters operated in this fashion until they were discarded for one or more of the following reasons: clogging, channeling, or the chemical and physical characteristics of the oil were no longer within specified limits.

TABLE II

Filtering Systems

Filtering media	Mesh size	Weight per filter,* lb
1. Activated alumina F-1	40-80	210
2. Activated alumina H-41	40-80	210
3. Silica gel	40-80	180
4. Fuller's earth	60-90	160
5. Activated alumina	Blocks	150
6. Activated bauxite	Blocks	150

*The filter units employed were all of the same volume capacity. The different weights listed, therefore, reflect the different specific gravity values of the absorbents.

The used granular activated alumina may be reclaimed through reactivation and then reused at normal efficiency. This is also true of some of the other media employed, such as fuller's earth. However, mechanical losses and other difficulties associated with thermal reactivation of oil-soaked absorbents are substantially less troublesome for the activated alumina materials. The length of the tests reported in this investigation was sufficient to insure reasonable indications of the life expectancy of the filtering media.

With one exception, all test engines were started with new filtering material and new oil. In this exception, the test engine utilized a new filter, but used oil, in order to determine the ability of an activated alumina to reclaim used oil while the engine was operating and the oil was in use. The results of this special test were very encouraging but do not form a part of this report. The tests lasted for about eight months and, during this time, all engines were used in production and were not specially treated in any manner.

The pressure and temperature of each filter, the engine operating hours, and the oil flow meter readings were recorded weekly. Samples of the oils were taken at bi-weekly intervals for chemical and physical determinations, as noted in Table III. Details of the du-Nouy ring method of determining interfacial tension have been published by Pope and Hall, Von Fuchs and others. See ASTM Bulletin No. 121, p25 (March 1943) by Pope and Hall, and IEC. Anal. Ed., Vol. 13, p306, 1941, by Von Fuchs, Wilson and Edlund. Interfacial tension values (against water) are functions of composition of the oil. The presence of polar additives produced through oxidation of the oil sharply reduces these values. Thus, this method is a most practical and sensitive means for following the course of oil oxidation. The neutralization number determination supposedly measures the extent of oxidation by noting the presence of materials which will react with alkali. However, all oxidation products do not react in this manner; therefore, this determination may not be as revealing as the interfacial tension method.

TABLE III

Periodic Oil Tests

Determination	Units	Method
1. Interfacial tension	Dynes per cm	Ring (now D971-50
2. Steam emulsion number	Seconds	ASTM D157-36
3. Viscosity	Saybolt seconds	ASTM D88-38
4. Color	.....	ASTM D155-39T
5. Neutralization number	Mg KOH per g	ASTM D663-42T

While neutralization numbers and interfacial ten-

TABLE IV

Life of Filtering Media

Filter	Total hours	Termination
1. a. Activated alumina F-1	4938	..... *
b. Activated alumina F-1	4802	Mechanical troubles
c. Activated alumina F-1	3964	..... *
2. a. Activated alumina H-41	7618	Filter clogging
b. Activated alumina H-41	4915	..... *
3. a. Fuller's earth	3476	..... *
b. Fuller's earth	3839	Oil did not meet specification
c. Fuller's earth	4685	Filter clogging
4. a. Silica gel	750	Oil did not meet specification
b. Silica gel	500	Oil did not meet specification
5. a. Activated alumina blocks	5166	Oil did not meet specification
b. Activated alumina blocks	4997	..... *
c. Activated alumina blocks	4567	Mechanical troubles
6. a. Activated bauxite blocks	3680	Mechanical troubles
7. a. None	2284	Oil did not meet specification

*Still effective when this investigation was completed.

sion values are usually sufficient to characterize the condition of the type oil employed in this investigation, the additional determinations provided interesting supplementary information. The other oil inspection data listed in Table III were determined as a matter of general interest only, because they are subject to considerable more controversy in interpretation than is true of the interfacial tension and neutralization number determinations.

The determinations listed and discussed, together with knowledge of the performance and internal appearance of the engines provided the basis for the conclusions drawn in this paper.

RESULTS

The lengths of test obtained with some of the filters are listed in Table IV along with the reasons for termination. During the course of these tests, new make-up oil was added periodically; this factor affects the data somewhat. The test period of eight months was sufficiently long, however, to justify the belief that the results average out for each engine.

The results listed in Table IV indicate that the life expectancies of the several filtering media are subject to wide variation. The maximum performance of some of these materials is yet to be determined, because they were still effective when this investigation was terminated.

One complicating feature of this investigation was the fact that some of the tests were stopped for other than filter troubles. In the case of mechanical difficulties with an engine in which an oil change or dismantling of the crankcase was required, the test of the filter was terminated since the engine would be started after the repair with new, unused oil. Therefore, the true lives of the filters attached to engines subjected to this type of misfortune were not determined.

Figures 2 to 4 inclusive, present some of the averaged data for each type of filtering media investigated. In each case the data are the averages computed from numerous individual engines. The experimental data for some of the materials are not plotted in order to avoid confusion. The values indicated on the graphs for zero hours of operation were actually for samples taken from the systems after a few hours of operation. All oils used started with the same physical properties. The aluminas thus had a more pronounced initial effect in preventing oil degradation than did the other filtering media. Comparisons among the various media may be made from the graphs.

An additional benefit derived from this work is an increased knowledge of the values of the various analytical methods used to determine the amount of oxidation and degradation occurring in a crankcase lubricating oil. For instance, the viscosity increase, color, and steam emulsion numbers were found to be more insensitive to those chemical changes than the interfacial tension values.

In addition to the experimental data mentioned heretofore, a few samples were analyzed for chloroform and naphtha insolubles in order to measure the tendency toward sludge formation of the oils. Some of these results are listed in Table V. Although the trend for all filters is toward a more dirty engine with time, the engines in each case were clean at the conclusion of the test; thus, the performance of all filters was highly gratifying. The results shown in Table V indicate very

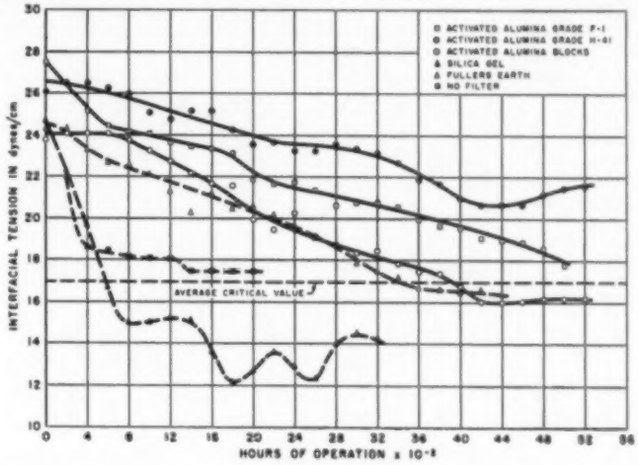


Figure 2 — Curve shows average variation of interfacial tension of crankcase oil with absorbant and time.

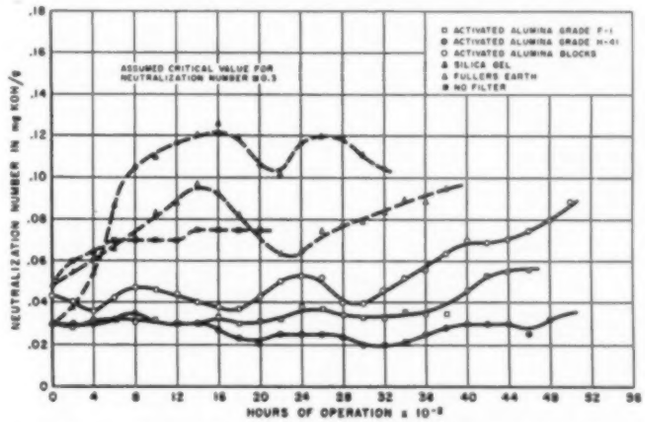


Figure 3 — Curve shows average variation of neutralization number of crankcase oil with absorbant and time.

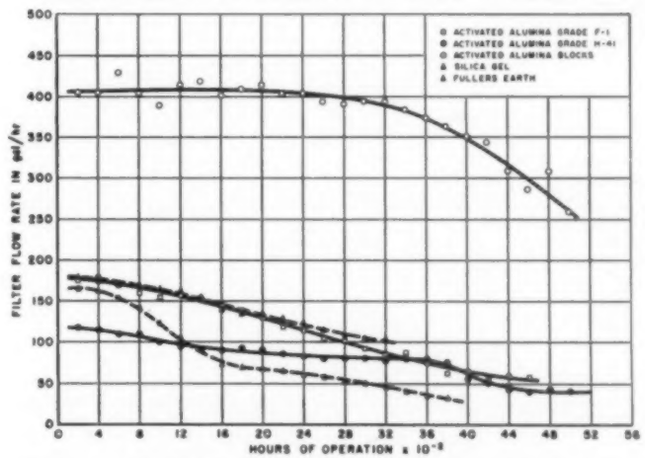


Figure 4 — Curve shows average variation of filter flow-rate of crankcase oil with absorbant and time.

little difference in cleanliness of the oils being maintained by the various media.

The oil flow through the block-type filtering media is considerably greater than through the bulk-type. However, these greater flows did not result in chemically or physically cleaner oil. Activated alumina H-41 had

TABLE V

Chloroform and Naphtha Insolubles of Crankcase Oils

Filter media	Hours of operation of filter									
	550		1300		2500		4000		5000	
	N	C	N	C	N	C	N	C	N	C
AA F-1	ND	ND	ND	ND	ND	ND	0.16	0.02	0.06	0.05
AA H-41	ND	0.02	....	....	ND	0.02	0.11	0.03	0.15	ND
Fuller's earth	0.14	0.02	0.12	ND	ND	ND	....	....	....	....
Silica gel	ND	ND	....	....	ND	0.03	....	....	....	....
Alumina blocks	0.08	0.02	ND	ND	ND	ND	0.21	0.08	0.22	0.06
Bauxite blocks	....	....	....	....	ND	ND	....	....	....	....

Legend: N = Naphtha insolubles, per cent. C = chloroform insolubles, per cent. ND = concentration too small for detection.

the least and fuller's earth the greatest decrease in flow rate in terms of gallons per 100 hours, and fuller's earth also had the greatest percentage decrease. Table VI presents these data, which give no direct indication of expected life of the filters. The life of the filters depends upon the initial flow rate and the rate of decrease of the flow both of which are subject to several variants.

Table VII summarizes the reliable data on the performance of the various filtering media, as indicated

TABLE VI

Flow Rate of Crankcase Lubricant Through Filters

Filtering media	Initial flow rate	Flow Decrease per 100 hr	Per cent flow Decrease per 100 hr
Activated alumina H-41	115 gal/hr	1.6 gal	1.4
Activated alumina F-1	175	2.7	1.5
Fuller's earth	165	3.6	2.2
Silica gel	180	2.2	1.2
Activated alumina blocks	405	3.0	0.74
Activated bauxite blocks	520	2.1	0.40

TABLE VII

Summary of Oil Inspection Data

Media	Neutralization number	Interfacial tension	Total
Activated alumina F-1	2	2	4
Activated alumina H-41	1	1	2
Fuller's earth	4	4	8
Silica gel	6	6	12
Activated alumina blocks	3	4	7
Activated bauxite blocks	3	3	6
None	5	5	10

by the averaged analytical results obtained on the oils. The best relative performance is indicated by a "1" and the next by a "2," etc. The ratings in Table VII are based upon neutralization numbers and interfacial tension values only.

DISCUSSION OF RESULTS

With regard to the results of this investigation, attention is called to the fact that activated alumina was evaluated in both loose granular bulk form, and prefabricated blocks. In the latter case, nothing is known of the manner in which the special methods employed to make the blocks may have affected the inherent properties of the activated alumina. The results obtained in the portion of the evaluation that concerned the various absorbents in bulk form indicate conclusively that the performance characteristics of activated alumina were either equal or definitely superior to those of the fuller's earth and other adsorbents investigated.

The performance of the activated aluminas in these tests clearly demonstrated the fact that they are less friable during handling and use than other media and resist the softening sludging action of adsorbed water to a much greater degree.

The fuel was a natural gas which had been taken through scrubbers in order to remove the undesirable constituents, and was of a very high quality, low sulphur, type. We had no troubles from this source. In that respect, we were indeed very fortunate because that is not always the case.

SUMMARY

1. The activated aluminas evaluated maintained the oil in as good or better condition under the circumstances of the test than did the fuller's earth and other adsorbents.
2. Interfacial tension determination appears to be the best single method of following changes in the condition of crankcase lubricating oils with respect to oxidation deterioration.
3. Steam emulsion number appears to be of little value in indicating the extent of oxidation of crankcase oils.
4. Activated alumina grade H-41 is superior to grade F-1.
5. Silica gel was without value as an oil maintenance medium in comparison with the others.
6. Condition of this crankcase lubricating oil appears to be unrelated to the flow rates through the filters in the ranges encountered.
7. Activated alumina is less friable than the other media tested.
8. Activated alumina apparently is more effective than the other media tested in maintaining oxidizing oils in proper condition during the initial few hours that the oil is in use.

ATOMIZATION of Liquid Fuels by High Pressure Natural Gas

By GEORGE GROSVENOR, Open Hearth Superintendent, Colorado Fuel and Iron Corp., Pueblo, Colo.

. . . . furnace production is increased by atomizing liquid fuels with high pressure natural gas . . . .

▲ THE use of high pressure gas at Colorado Fuel and Iron Corp. has been a development which has taken place in a series of steps since 1949 when Gene Miller of the combustion department was assigned to the open hearth for this development work.

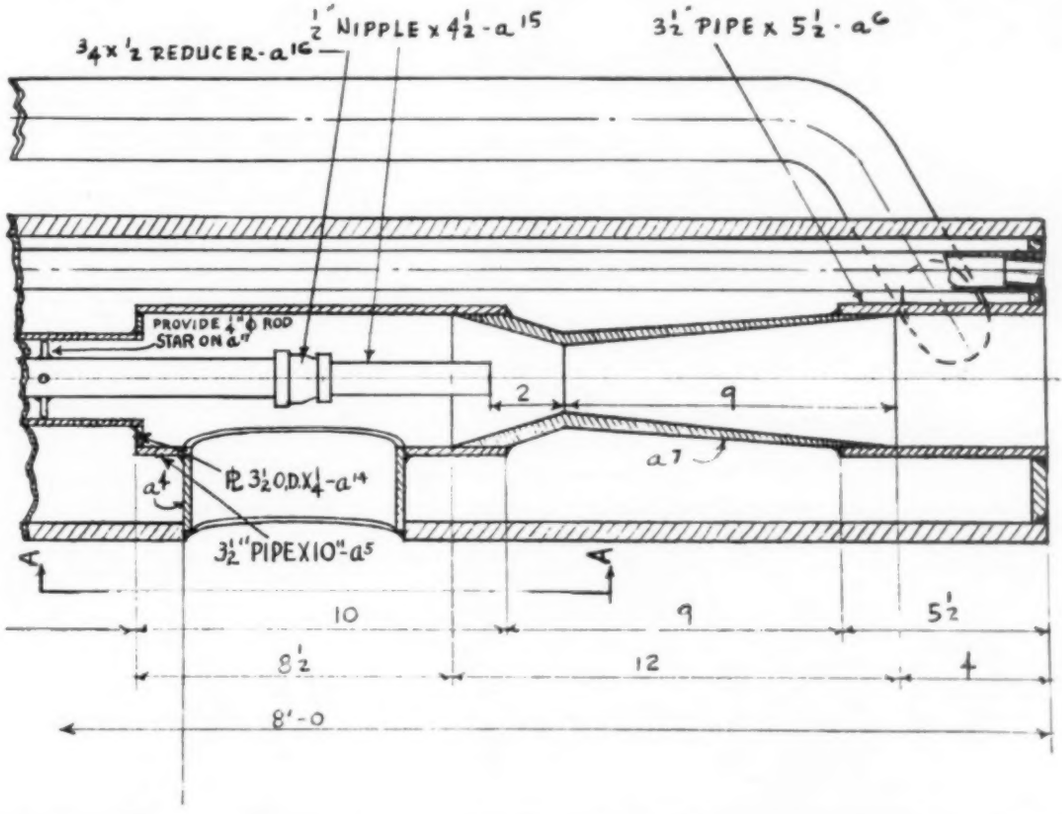


Figure 1—Sketch shows venturi and air port through burner shell in front end of gun.

It was recognized that flame temperature is not necessarily by itself, a criterion of the effectiveness of a fuel for a particular work. The effectiveness of a flame is not altogther measured by temperature but by the intensity of combustion. In the case of an open hearth flame, it is the brilliance of the incandescence which is produced in the split second transitional period in the reaction when the free carbon is released from the heavy fuels reaching its maximum incandescence before combining with the 0_2 present.

Mr. Miller's work was centered on the importance of the removal of the inner cone and its controlling effect on the rate of flame speed. In this development, the inner cone has been partially eliminated and substituted in its place is a sharply defined area of maximum flame heat.

When the kinetic energy of the fuel input is derived almost entirely from the use of steam, one can readily perceive why the elimination of steam from the flame

area is desirable development. In the flame itself, the reaction processes are profoundly affected by the presence of the steam.

In short, what occurs is this, the four, five, or six pounds of steam per gallon of oil which is introduced with fuel, being in the flame area, goes through the

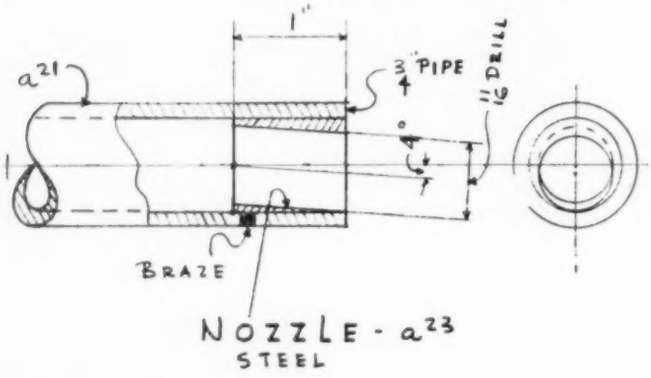


Figure 2 — Nozzle block angle of top gun is 4 degrees.

process of dissociation into its component parts. This process of dissociation absorbs a tremendous amount of energy and in an area where it will materially reduce the intensity of the flame. An equal amount of energy is given up as the reassociation of the elements takes place but unfortunately takes place where the least amount of benefit can be derived.

The first burner developed at C.F.&I. in 1949 was constructed for premixing natural gas and air or oxygen before entering the furnace. This was accomplished by the utilization of cold primary air induced through the use of a patented venturi mixing chamber with the fuel oil being atomized with steam. This burner was used on No. 7 furnace in 1950 and a monthly record was attained using seventy per cent of the total Btu input from natural gas, at an ingot cost saving of twenty cents per ton. This saving was primarily due to the difference in the cost of the two fuels.

Due to the shortage of natural gas through the winter months, it was necessary to develop a burner for liquid fuel only. This phase of the development led to the use of a double gun burner, using steam and compressed air as the atomizing agents. This proved very satisfactory and as natural gas became more plentiful, high pressure natural gas was used as an atomizing agent.

All preliminary work was done on small scale models and operated in the open which permitted a close study of flame patterns. The design of a full scale burner was based on the desired flame pattern of the small models.

The study procedure included the use of natural gas of pressures up to 150 psi with various sizes and shapes of nozzles. The oil and air combinations were studied in the same manner. This work was based upon the theories which would permit the maximum utilizations of the inherent kinetic energy to be gained from high pressures. The bottom section of the burner is essentially a venturi with an air port through the burner shell, opening inside the furnace, which permits the use of superheated air from the uptakes, as shown in Figure 1. This resulted in a short flame of high temperature and radiation. The angle and shape of the nozzle block in the top gun projects the high pressure gas and fuel oil mixture through this area of maximum temperature, where the high kinetic energy content causes very rapid mixing and produces a high rate of flame propagation of the entire fuel input giving a short compact flame of intense temperature and radiation.

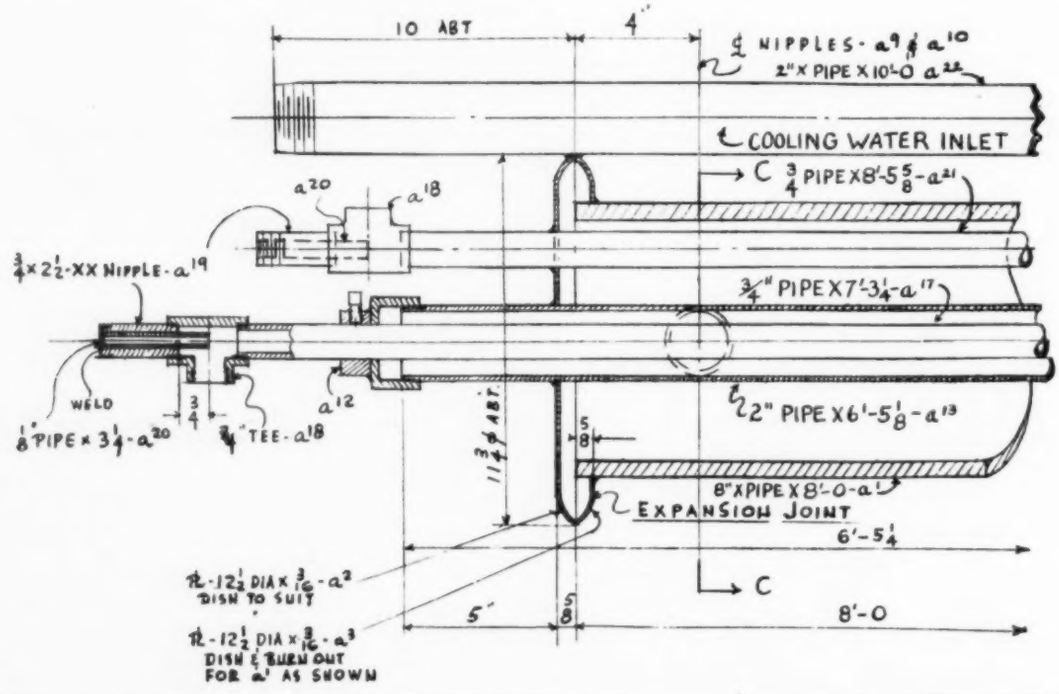


Figure 3—Section through back end of gun.

Figure 2 shows the nozzle block angle of the top gun.

After the preliminary and experimental work had been completed, and the desired flame pattern had been obtained, a full scale burner was built for furnace trial.

Figure 1 as shown and Figures 3, 4 and 5 show the

detail section of the burner for which patents have been applied by Mr. Miller.

We found that most furnace crews approach the use of high pressure gas with a great deal of timidity, for this reason considerable care was taken in the selection of a furnace crew for the trial period, and today, through an educational program this fear of high pressure gas has been effectively eliminated with most of the men.

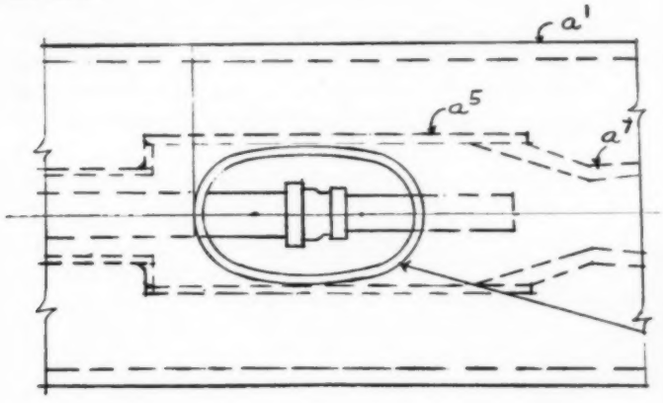


Figure 4 — Sketch shows enlarged section of air port through burner shell.

After due consideration given furnace crews, the first burner was placed on No. 16 furnace in September 1952. It was so constructed that the fuel could be atomized with either steam, air, natural gas, or any combination of these atomizing agents. We have found that our best results have been obtained through the use of natural gas at 140 psi pressure in both top and bottom burners, but the temperatures are so high that extreme care must be taken during the shaping-up

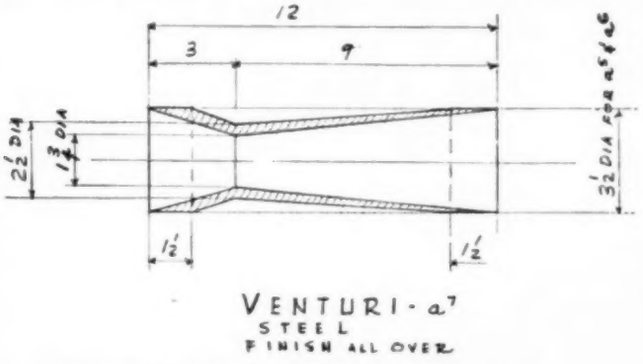


Figure 5 — Enlarged detail section of venturi.

period of the heat to prevent burning the roof. Due to this condition, some of our furnacemen are changing from natural gas to steam for atomizing during this period on the bottom burner. In October the production on No. 16 furnace was increased from 9,586 net tons to 10,373 net tons with the furnace being down during the month for a shot-gun or a quick roof. This was an increase of 787 net tons. In January of 1953 the monthly record was again raised to 11,073 net tons or an increase of another 700 net tons making a total increase of 1,487 net tons. However, this increase cannot be contributed entirely to the use of high pressure gas. Hot metal was increased in our charge from 46 to 56 per cent during the same period, but the only furnaces in which we have been able to produce 10,000 net tons or better, have been on the furnaces using high pressure gas. During January 1953 on No. 16 furnace, we tapped 95 heats, with an average tap-to-tap time of 7 hours and 56 minutes, and a charge-to-tap time of 7 hours and 09 minutes and for one week during that month, we tapped 24 heats giving a rate of 404 net tons per furnace day, or 31.98 tons per hour per 1,000 square feet of hearth area. Due to this performance on No. 16 furnace, we have just completed installing a new 10-in. high pressure gas line throughout the shop.

By the use of an optical pyrometer we are getting flame temperatures ranging from 3450 to 3600 F at the No. 1 and No. 2 door peep holes, with the flame tailing out at the No. 3 door and with a temperature of 3100 F at the No. 5 door. During this record performance, we tapped two 110-ton heats in 4 hours and 55 minutes

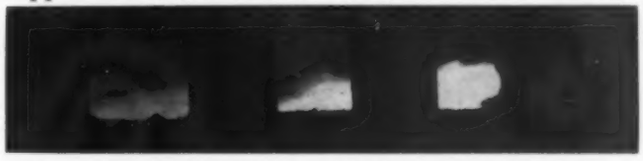


Figure 6 — Flame pattern with both top and bottom burners operating.

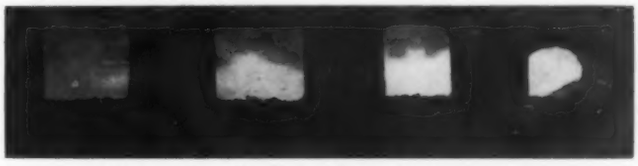
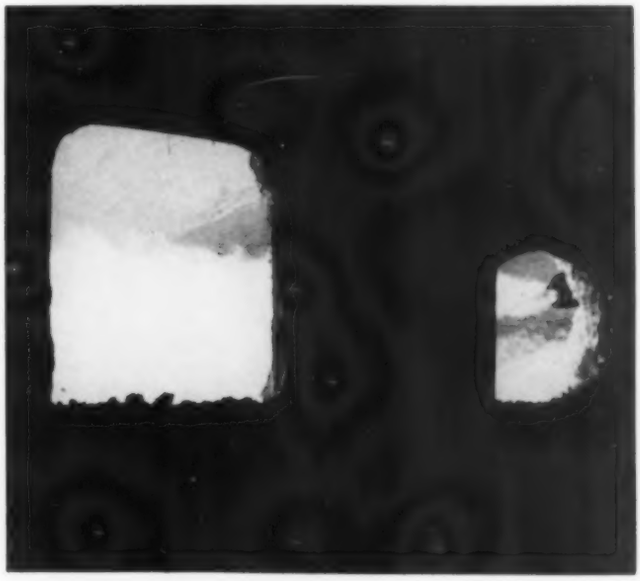


Figure 7 — Pattern of top burner only.

Figure 8 — Pattern of bottom burner only illustrates the rapid flame propagation and the area of maximum temperature.

Figure 9 — View shows the nose of the burner and the angle in which the high pressure gas and fuel oil is prejected through this area of maximum temperature.



and any number of five and six hour heats with an average two-hour charging time. Our job today is to reduce our charging time of scrap if additional tonnage is to be made.

The flame pattern is shown in Figures 6, 7, 8 and 9.

Figure 6 shows flame pattern with both top and bottom burners operating. Figure 7 shows pattern of top burner only. Figure 8 shows pattern of bottom burner only illustrating the rapid flame propagation and the area of maximum temperature. Figure 9 shows the nose of the burner and the angle in which the high pressure gas and fuel oil is projected through this area of maximum temperature.

Experience has shown us that the use of high pressure gas in this manner has had no detrimental effects on roof life. Roof life actually has shown a 10 per cent increase on this furnace, but as most of you realize this can probably be contributed to the additional attention given to the furnaces.

The sensitivity of these burners and the extreme temperatures obtained makes it desirable to have close cooperation between the furnacemen and the fuel department personnel. Instrument setting of the furnace is very practical, in fact, a required practice in order to obtain the maximum operation from the furnace. This condition presented an opportunity to conduct an educational program on the use of this fuel. A class was held once a week with one melter and his group of first and second helpers. The program was set up to utilize the practical knowledge which these men have obtained through experience and the simple presentation of the technical background of the burner with the idea of placing them on their own initiative in determining the proper furnace setting and fuel usage to gain the greatest advantage from their individual furnaces.

This type burner is especially valuable in a shop with a high scrap charge. Scrap melt-down occurs at a remarkable rate, and thus much overall heat time can be saved. We have also noticed, that in many cases, half of the limestone is pulled by the time the ore flush is completed, and that the furnace is hot and ready to tap when the lime is up.

Fuel consumption on the high pressure gas furnaces is averaging approximately 4,620,000 Btu per ton of steel while the shop average is 4,920,000 Btu per ton. This is not good, but up until this time the emphasis has been placed on tonnage with little attention to fuel consumption. Today emphasis is being placed on fuel as well as tonnage, and surprisingly as it may seem, we have tapped heats with as little as 2,000,000 to 2,800,000 Btu per ton. This must be our ultimate goal, but there are many problems in an open hearth we must overcome before this can become a reality. The biggest problem that confronts us today is the instilling of a desire in the individual the pride of accomplishment of his work.

AISE

WEST COAST MEETING

ST. FRANCIS HOTEL San Francisco, California

March 21, 22, 23, 1955

PLAN TO ATTEND

Make your reservations

NOW!

Temper Mill Control

By GEORGE P. DIRTH
Electrical Engineer
Granite City Steel Co.
Granite City, Ill.

. . . . the basis of temper mill control remains the same although the method may vary on different mills . . . .

▲THE modern two stand temper mill has evolved from a comparatively simple single stand mill to the complicated unit of today. This complexity has been reflected in the electrical control. Within the past eleven years, a lot of good work has been published by the AISE on temper mills. There is no need for duplication, but the writer feels a fundamental analysis of temper mill control would be of value to some electrical engineers employed by the steel industry.

SOME PRIMARY CONSIDERATIONS

The work of tempering is usually expressed as a strip elongation of from 2 to 4 per cent while being rolled. This work is done by a combination of tension and compression*. The exact values are governed by the end results desired and by different rolling techniques. In spite of the possibility of wide variations in rolling practice, most two stand temper mills are operated by using two basic principles.

1. Tension is applied between stands while the strip is being worked in compression on Stand No. 1 to obtain a given elongation.
2. Tension is held between Stand No. 2 and the delivery tension rolls as the strip is in compression on Stand 2 to insure an even elongation.

Any two stand temper mill operated in this manner will have at least three characteristics in common:

1. No. 2 stand will be the pilot stand; obviously, every drive pulls forward or backwards to No. 2 stand.
2. The value of tension can be changed between stands without upsetting the tension balance in the strip.
3. Stand No. 2 must assume part of the load of Stand No. 1 in order to hold tension between stands. If Stand No. 1 motor were to do all of Stand No. 1 rolling work and furnish the tension necessary to balance the back tension of the entry side of the mill, there would be no tension between stands. Stand 2 motor can assume any part of Stand 1 work by means of a tension between them to transfer the added torque requirements to No. 2.

Any control for temper mills with these three characteristics will:

1. Control the reels or tension devices to drag or pull as desired.
2. Control Stand 1 so that any proportion of load at No. 1 may be transferred to Stand 2.
3. Regulate for constant tension.

A common bus, a separate bus for each device, or a combination of common bus and separate buses can be used.

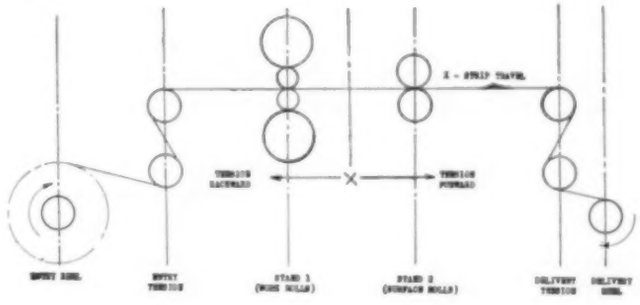


Figure 1 — Simplified line diagram of a two-stand temper mill.

SOME SPECIAL CONSIDERATIONS

1. *Separate bus vs common bus*—Aside from the desired flexibility of a separate bus, there can sometimes be an economic justification for choosing them. For example, consider a temper mill with a speed ratio of 2000/5000 fpm. The maximum coil diameter is to be 72 in. with an entry reel pitch cone diameter of 20 in. and delivery reel mandrel diameter of 17 in. The field ratios of the tension roll and stand drives would be 2.5/1. The total ratios necessary to maintain constant peripheral speed of entry and delivery reels would be 9/1 and 10/1 respectively. At least two boosters would have to be used on a common bus and the reel drives would prob-

*Numbers in parentheses refer to the bibliography.

ably be specially produced. On the other hand, double sized motors with field ratios of 2.5/1 could be used on separate buses. The speed regulating method would be divided between variable voltage and field weakening in each case. The economic consideration then becomes a comparison of costs between boosters and specially produced reel drives vs motors and their supporting generators that probably are stock items. In extreme cases, such as an exceptionally wide temper mill, it might be justified from a cost standpoint to eliminate all of the boosters. and use separate buses throughout.

2. *Method of obtaining constant tension*—Temper mill drives are usually selected for maximum tension at base speed for the greatest strip width and minimum tension at maximum speed for the narrowest strip width[2]. A convenient method is to regulate the drives for constant current at all times, then the tension will vary inversely with strip speed for different field settings. There is an inherent danger that exists when a separately excited shunt motor is regulated for constant current. It assumes all of the undesirable characteristics of a series motor and will run away when the load is removed. Therefore, the drives of a temper mill should never be in a current regulating condition without tension being applied. This requires ordinary emergency provisions, such as circuit breakers being opened and dynamic braking applied to the armatures. "Stall tension" is applied to the entry and delivery reels when the mill is standing still. This is done by raising the armature voltage just to the point where full load current circulates in the armatures at standstill. Tension is applied to the other drives immediately when their armatures are energized and the strip moves forward.

3. *Tension measuring devices*—When running, tensions can be measured by a specially calibrated wattmeter that reads the product of current x counter emf of the drive in question. This also could be done by specially calibrated ammeters indicating the current of the drive in question. Tension between stands must be measured by a special device since it is difficult, if not impossible, to separate the load between rolling work and tension by electrical means alone.

4. *Method of current regulation*—The most practical method of current regulation is to regulate the armature voltage for constant current. This has the added advantage of eliminating the necessity of IR drop compensation when using the Ward Leonard system of speed control. For example, motors on a Ward Leonard bus will have their speeds directly proportional to the bus voltage minus a constant IR drop when regulated for constant current. The supporting generator voltage is regulated for constant current in a separate bus section. The total armature voltages are regulated for constant current by regulating the booster voltages on a common bus.

5. *Control of back tension by regenerated power*—For any drive to supply back tension it has to be dragged along against its will. This means that the entry reel and tension drives will be acting as generators. It is also obvious that any drive used for the sole purpose of exerting tension returns energy to the supply system.

There are three basic conditions to be fulfilled in order for a machine to regenerate power.

a. The voltage of the regenerating machine must be greater than the bus voltage.
b. This voltage must be accurately controlled at all times.

Both of these conditions can be fulfilled on either a common or separate bus. A booster will regulate the total armature voltage of a dragging machine on a common bus at a value greater than bus voltage. This voltage can be maintained by regulating the booster voltage. In a separate bus section, the supporting generator voltage is regulated at a value below the emf of the dragging machine. In both cases, the current from the dragging machine can be varied by changing the net difference between the total armature and bus voltage.

c. Other machines must be on the bus that are using power: when dragging machines are on a common bus, the regenerated power lowers the required supporting generator capacity. It is common practice for several generators to be keyed to the shaft of one prime mover. A generator used to support a dragging machine would run as a motor and relieve the prime mover of its load. If a generator receiving power from a dragging machine were driven by a separate induction motor, the motor would be driven faster than synchronous speed in a condition of negative slip and operate as an inductor generator. This same generator backed up by a synchronous motor would initially try to speed up the motor and succeed in changing the displacement angle between the rotor flux and armature flux. The rotor flux would then be ahead of the armature flux in regards to rotation and the machine would act as an alternator.

6. *Special case of Stand No. 1—No. 2 Control*—As mentioned earlier, the only way for tension to be exerted between stands while No. 1 Stand is doing rolling work is for No. 2 to assume part of the load of No. 1. By "boosting" the total armature voltage of No. 1 Stand motor on a common bus; the driving torque and armature current are decreased. But the stand is pulled along by No. 2 Stand. The added torque requirements of No. 2 are transferred from No. 1 Stand by the increased tension in the strip. Tension can be increased by lowering this current value of Stand 1 motor and decreased by raising the armature current. Similarly, on a common bus tension is raised by "boosting" the total armature voltage and lowered by decreasing the total armature voltage of No. 1 Stand motor. The supporting generator voltage is lowered to increase tension and raised to decrease tension in a separate bus section. In either case, tension can be increased to the point where No. 1 Stand is pulled along by No. 2 Stand and acting as a generator.

7. *Forward tension beyond No. 2 Stand*—Also, as mentioned earlier, No. 2 Stand is the pilot stand. In order for the delivery tension device to exert forward tension against No. 2 the delivery tension has to pick-up some of the load of Stand No. 2. This same situation exists between the delivery reel and the delivery tension device. In order for either of these drives to pick up the load, the armature current has to be increased. Lowering the total armature voltage with a series booster will cause an increase of current in their arma-

tures on a common bus. This increase of current causes them to accelerate slightly, and the current regulator forces a balance between speed and torque. Delivery tension and reel armatures are regulated for constant current on a common bus by regulating a series booster. When a separate bus is used, the supporting generator voltage is raised and regulated at this value.

8. *Some special considerations for the reels:*

a. *Entry reel*—With a constant strip tension, torque on the entry reel drag generators must decrease as the coil diameter grows smaller. Therefore, the drag generator flux densities must be controlled to decrease in direct proportion to decreasing coil diameters.

b. *Delivery reel*—In order to hold constant strip tension, torque exerted by the delivery reel motor will have to increase with increasing coil diameters. This makes a control to increase the motor flux density in proportion to coil build-up necessary. As an added precaution, it is a good idea to add a special control in the delivery reel circuit to keep it from running away in the event of strip breakage. At other points, the operators would probably have time enough to "hit" the "Emergency Stop" button before any serious damage was done. Some control manufacturers provide speed limiting circuits as a part of the control for each device.

9. *IR drop compensation—*

a. As mentioned earlier, IR drop compensation is unnecessary when regulating the armature voltage for constant current on a Ward Leonard bus. If the motor fields were to be regulated for constant current, IR drop compensation would be necessary.

b. IR Drop Compensation as an Added Refinement of Control: IR drop compensation is not always provided for No. 2 Stand, as it is the "pace setting" stand. For instance, No. 2 Stand motor and all other motors have their fields set at a constant value corresponding to the desired speed. Stand No. 2 motor is the only one that is not being regulated for constant current at all times, but all other motors pull away from or ahead of it. Therefore, for any speed of No. 2 Stand drive, current regulators on the other motors force the proper balance of speed and torque in relation to the speed of No. 2 Stand. If additional accuracy of control of mill speed is desired. IR drop compensation can be added for No. 2 Stand motor. By the same token, IR drop compensation is added to all the drives for control of thread speeds.

10. *Threading provisions* — Threading the strip through the mill becomes an important consideration. Probably the most important development in cutting down threading time has been the concept of "belt wrapping" at the delivery reel in order to successfully "thread on the fly." There is no strip tension when threading, therefore, all drives have to be taken out of their current regulating condition. Threading speeds in reverse are provided for by reversing the bus voltage.

11. *Acceleration*—The acceleration of a temper mill is another important consideration. Constant strip tension must be held during acceleration as well as at all other times the mill is in operation. As mentioned earlier, the mill should never be in a running condition without strip tension. Therefore, temper mills are always accelerated from and decelerated to a condition of stall tension. A compromise must nearly always be made between permissible overload capacity of the drives and the operators' desire to keep the acceleration time down, as "off gage" strip is rolled during acceleration. The accelerating time generally ranges from ten to fifteen seconds on temper mills installed today.

The "balance" that is necessary in order to maintain constant strip tension during acceleration is obtained by either adding torque or deducting it, depending upon the position of a motor in the mill and whether acceleration or deceleration is taking place. In each case, the value of the torque to be added or deducted is exactly equal to the inertial torque required by the device during its acceleration period. This balanced condition must be accurately controlled, whether the compensation for inertial torque is obtained by a change of field strength or a change of armature current. In either case, the current during acceleration must be closely controlled. The pitfalls of not making this control accurate are possible looping between points and strip breakage.

The compensation required during acceleration is to deduct torque at the entry reel, entry tension. Add torque at Stand No. 1 drive, delivery reel and delivery tension drives. In deceleration, the situation is in reverse. Torque is deducted at the delivery reel and delivery tension drives and Stand No. 1. Torque is added at the entry reel, and entry tension. As you will notice, no mention has been made of compensation in any form for Stand No. 2. The current in No. 2 Stand's armature will inherently increase, until it will increase at the same rate the bus voltage is increasing.

12. *Variable torque operation*—As mentioned earlier, temper mill drives operate with maximum torque at base speed when processing the widest strip, and minimum torque at maximum speed when processing the narrowest strip. Two commonly used methods of accelerating to any desired speed are:

a. Accelerate to base speed with full field by variable voltage and to higher speeds by field weakening.

b. Accelerate to a given speed with a "preset" field. This field setting is determined by the desired torque and speed while running.

Both methods have their advantages and disadvantages. The first method has the advantages of a constant rate of acceleration and full torque at starting. Some of the disadvantages are: the control has to anticipate the point of "switch over" for the weakened field changes, two fluxes have to be changed, flux of the generator and motor. For example, if a 2.5 to 1 torque setting is to be used, the generator flux has to be changed in two-thirds the time taken to change the motor flux. Also, if constant tension is to be held in the strip, the acceleration cannot be carried out with constant current. The "preset" field idea offers several distinct advantages that are readily adaptable to controlling the acceleration of a temper mill. The control is simpler and acceleration can be carried out with constant current. This is a useful characteristic that

good use can be made of to help maintain constant tension during acceleration. The preset field has its disadvantages, however. Either a variable speed motor operated rheostat to control the rates of change of the bus voltage for different field settings is necessary; or the inertial compensation control must be variable.

13. *Load balancing*—It is becoming common practice to have a separate drive for each of the stand work rolls as well as for each roll of the tension devices. Load balancing provisions are usually included for the stand drives, and load proportioning control for the tension roll drives.

14. *Compensation for roll changes*—Any compensation necessary because of roll changes is easily taken care of. This compensation can be made by making a small change in the generator field excitation on a separate bus or the booster field excitation on a common bus.

15. *Relay assignments*—The controller relays have to get the current regulators in and out of operation as the mill is started and stopped. They have to set up special circuits for threading speeds, and get the inertial compensation provisions in and out of operation on acceleration or deceleration. The emergency provisions for stopping also have to be relayed into operation when needed.

16. *Control stations*—Usually full operating controls are provided on the entry and delivery ends of the mill. Jog switches for multiple and individual operation are provided. The delivery station has the controls for line operation such as raise, hold, lower and multiple jog. The delivery operator also has all tension controls from Stand No. 1 onward, plus the entire tension metering before him. The entry control station has the entry tension controls and entry end tension metering.

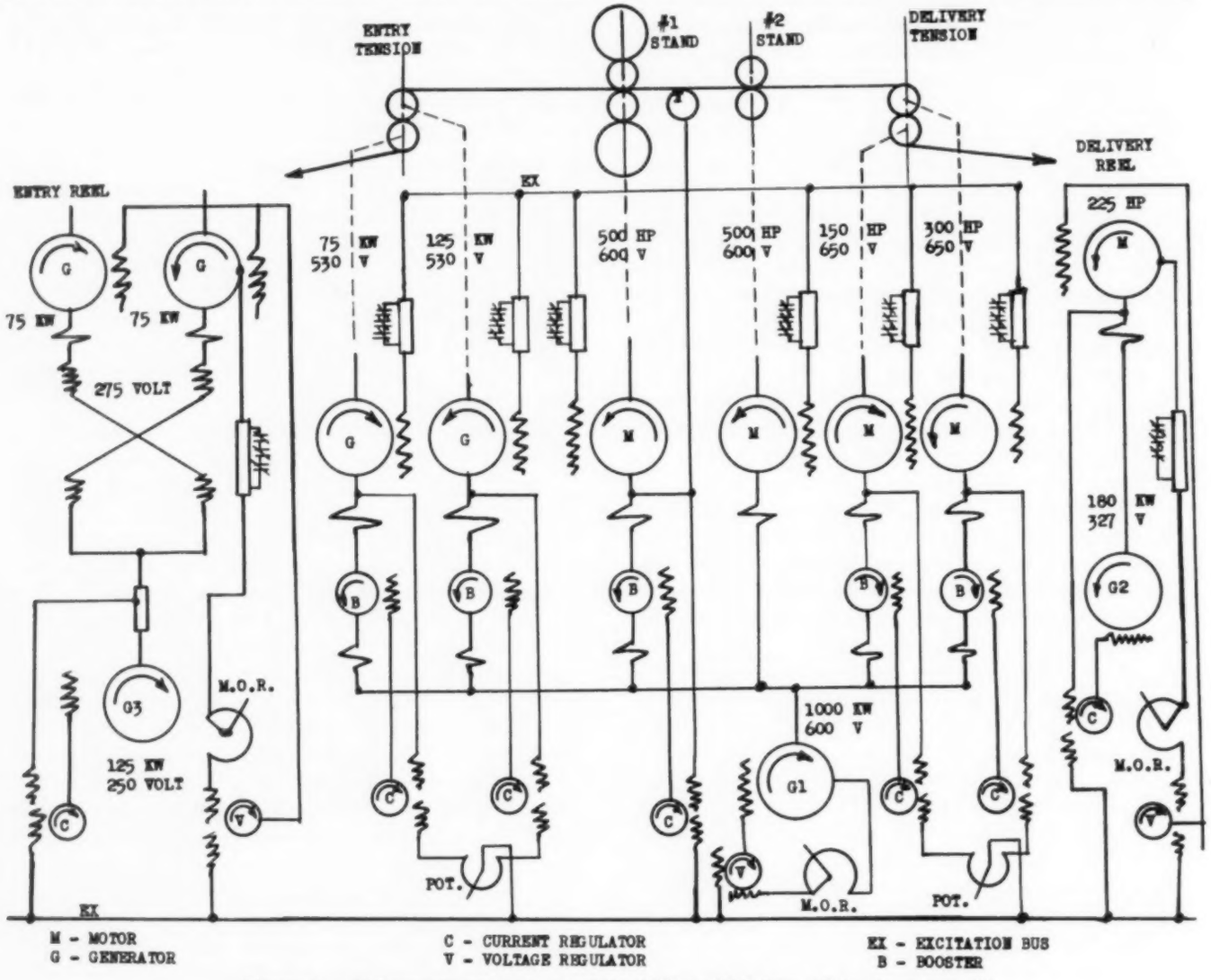


Figure 2 — Schematic shows control for 1275 to 3000 fpm, 48-in. temper mill.

EXAMPLE OF AN INSTALLATION

Probably the best way to explain temper mill control is to follow through the details of an actual installation. However, here all generalization ends. To set forth the basic principles of what is being accomplished within a temper mill is easy. To devise an actual control is quite a different matter. Probably no two temper mills in the country are exactly alike. This is especially true of those of different control manufacture. Each of the control manufacturers in the field of temper mill control will provide for the general considerations listed ac-

cording to their own individual methods and ingenuities. But, a much better understanding can be gained by examining the method used in one specific case.

A 1275/3000-fpm, 2-Stand installation was made at Granite City Steel in 1951. Figure 2 shows the motor ratings, and a simplified schematic. A common bus is used for the stand drives and tension devices, separate buses for the reels. There are four line speeds available; 1275 fpm, 1600 fpm, 2400 fpm and 3000 fpm. Four field settings are provided for motors on the common bus sections, these determine the various line speeds. Speed settings are provided in the reel circuits also, but these are to compensate for the effects of higher speeds of reel operation.

Constant current is maintained at all times in drives on the common bus. Then, tension at any speed is dependent on the field setting selected. Once tension is set for a given line speed in the reel drives, regulation for that particular speed is, as commonly called, for constant horsepower. But, as the primary purpose for varying flux densities of the reel drive is for the speed regulation, the regulated value of current is changed for different tensions. Constant current regulation in the common bus section is accomplished by regulating booster voltages. Constant current in the separate bus sections for a given tension at a particular line speed is obtained by regulating the supporting generators for constant current.

The speed control is Ward Leonard with acceleration to line speeds by the preset field method with constant current. As the acceleration periods for different field settings are unequal, the motor operated rheostat controlling the rate of change of bus voltage has four successively slower speeds.

NORMAL RUNNING PROCEDURE

"Start"—Both reels in condition of stall tension.

"Run"—Mill accelerates to line speed by variable voltage.

"Lower"—Mill decelerates back to condition of stall tension.

"Stop"—Reels taken out of stall tension.

VARIABLE VOLTAGE CONTROL IN THE COMMON BUS SECTION

The rate of voltage increase in the common bus section is controlled by a variable speed motor operated rheostat (M.O.R.). When the operator presses the run button, the M.O.R. starts its travel. After full travel or full voltage is reached, a limit switch stops the travel and relays the special accelerating provisions out of operation. Upon decelerating; the M.O.R. starts its travel in a downward direction. A limit switch stops the travel and relays the special decelerating provisions out of operation. Generator (G^1) voltage is regulated at a constant value by a rotating regulator in control of the generator's field. This particular application of a rotating regulator regulating a generator's output voltage is a commonly used one and is well covered in the literature.

CIRCUIT DETAILS

The specific regulating circuits used for each device, excepting generator ([1]) are now to be taken up. In each case, the circuit diagrams are simplified. Only details pertinent to regulator operation are shown. All stabilizing elements are neglected, because the subjects associated with them are too abstruse and beyond the scope of this paper ([3]). All regulating circuits shown in Figures 3 to 6 are in an energized condition.

When considering regulator schematics to be used for the control of d-c machines, each machine's rotation should be known. The convention to be followed is:

1. Clockwise rotation, field current direction from odd subscript to even.
   a. Motor—armature terminal, A_1 is plus.
   b. Generator—armature terminal A_2 is plus.
2. Counter clockwise rotation; field current direction from odd subscript to even.
   a. Motor—armature terminal A_2 is plus.
   b. Generator—armature terminal A_1 is plus.

DELIVERY TENSION DEVICE

The regular schematic diagrams of Figure 3 are for the lower delivery tension device booster. Both boosters

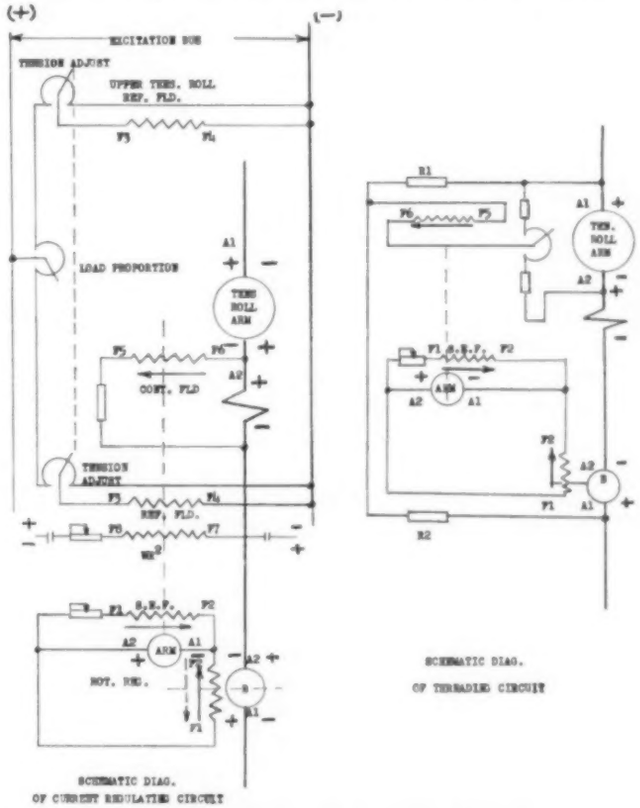


Figure 3 — Schematic shows delivery tension or entry tension control.

are regulated in the same manner. As indicated in Figure 2, the upper delivery tension device drive is larger than the lower and a load proportioning control is necessary.

The amount of load to be assumed by each motor is controlled by its series booster. The value of current and torque is greater than if the motor's operation were

governed by its normal characteristics alone. The regulated current value will be dependent upon the net difference between the total armature voltage and bus voltage. Therefore, current and tension are controlled by regulating the booster voltage. It can be any value necessary at a particular time to maintain constant current. For instance, if it is necessary to lower the total armature voltage the booster voltage increases. Or, it decreases to raise the total armature voltage. In extreme cases where it becomes necessary to suddenly raise the total armature voltage, the booster polarity can reverse and then the booster will be aiding the motor instead of opposing it. The reference field setting made beforehand will determine the balance point about which the rotating regulator controlling the booster voltage will act. The tension roll drive's interpole supplies an IR drop that furnishes the driving emf for the rotating regulator's control field. Then, the regulated current value will be that which produces control field excitation equal to reference field excitation. The rotating regulator will act to change the booster voltage which in turn corrects any change from the desired value. A potentiometer marked "Load Proportioning" in Figure 3 is used to determine the total drop across each reference field. Two other potentiometers, mechanically connected together, determine the "operating" reference field excitation of each regulator. The operator can "set" the tensions of upper and lower delivery tension rolls in any ratio he desires, limited by the rating of each machine.

At the beginning of the accelerating period, excitation is applied to the drive and regulator. The reference field $+F_3$ $-F_4$ predominates and the regulator voltage begins to build-up. This build-up is soon limited and stopped as the current reaches its regulated value, and control field $-NI$, $+F_6$ $-F_5$ equals reference field $+NI$. At any time during the rest of the accelerating period, the booster voltage either is driven up or down, whichever the case may be, in order to regulate the total armature voltage for constant current. Assume the booster polarity remains as shown in Figure 3, opposing the motor. An increase of armature current would decrease the booster voltage to raise the total armature voltage and restore constant tension. On the other hand, a decrease of tension would raise the booster voltage to increase armature current to its regulated value. After the accelerating period and during the operation at line speed, the booster continues to fluctuate about a voltage necessary to control the total armature voltage for constant current. The total armature voltage is regulated for constant current during deceleration as the M.O.R. lowers the bus voltage in the same manner as the other two cases. The booster will quickly assume any voltage needed to keep the net difference between the total armature voltage and bus voltage constant.

As mentioned earlier, this particular mill accelerates with preset fields and constant current. Each field setting progressively weakens the fields of the drives on the common bus that are regulated for constant current. Longer periods of time are taken to accelerate to the higher line speeds. A constant change of armature current during acceleration will result in four progressively lower values of inertial torques, each consistent with increasing acceleration periods.

The WR^2 field is relayed into operation $+F_7$, $-F_8$ at the beginning of the acceleration period. This has the effect of increasing the reference field and thereby the armature current during acceleration. When decelerating, the WR^2 field is in a $+F_8$, $-F_7$ condition, the effect is to reduce the reference field excitation and the armature current.

A special circuit is relayed into operation for threading purposes. The delivery tension drive is taken out of constant current operation and placed in controlled voltage operation. The potentiometer marked "Thread Adjust," the booster voltage and interpole drop from two legs of a bridge circuit, resistors R_1 and R_2 form the other two legs. The tension roll drive armature voltage furnishes the driving emf of the bridge. Naturally, there is a different "Balance" voltage for each potentiometer setting. The common bus voltage is raised to a threading voltage for thread speeds; and as there is no compensation of any form on No. 2 Stand, it will assume a speed not in direct proportion to this voltage. Then, threading speeds of the delivery tension device can be adjusted to match the speed of No. 2 Stand by adjusting the potentiometer. Any IR drop compensation necessary to keep the delivery tension drives in step with No. 2 Stand is provided by the booster and interpole being included in one leg of the bridge.

When the thread circuit is relayed into operation, the reference field is taken out of use. The control field acts as a reference field initially, and as the bridge balances, the self excited field builds up to maintain regulator excitation. Any unbalance of the bridge will correct the regulator voltage accordingly.

ENTRY TENSION DEVICE

The entry tension device will operate as a regenerating machine on the common bus. The value of regulated current will be dependent upon the net difference between the total armature voltage and bus voltage, total armature voltage being greater than bus voltage. Although the armature current does not change direction, the dragging action results in a "power transfer" back to the bus.

The booster polarity is reversed during operation and the reference field will be furnishing a constant "Balance" to regulate the value of armature current. Therefore, reference field excitation is a direct measure of tension. Load proportioning and tension adjustments are accomplished in the same manner as in the case of the delivery tension devices.

The schematics shown in Figure 3 are for the lower tension roll booster. Both boosters are regulated in the same way. When excitation is first applied to the lower entry tension drive and its regulator, polarities are $+A_1$, $-A_2$ for the booster. Before acceleration begins, the booster operates as a generator and furnishes all of the armature current. Booster excitation is furnished by the regulator which has built up in voltage until the interpole IR drop furnishes excitation for the control field, $+_6$, $-F_5$ to balance the reference field $+F_3$ $-F_4$; as soon as the motor is in motion, its polarity

changes to $+A_2, -A_1$. This is a polarity that will "Aid" the main generator. The emf of the motor increases and raises the armature current. Both motor and booster are operating as generators in this instant. Now, a transition begins that is carried out smoothly, while maintaining a constant armature current. The booster voltage decreases as the emf of the tension roll drive increases. When the emf equals the original booster voltage, booster voltage is zero. During this transition, the regulator has had its excitation lowered by the action of the control field. Each increase of emf momentarily increased the armature current and upset the balance between reference and control fields. Each time the balance has been upset; the regulator has lost excitation, until the booster output voltage is zero. Any further increase in armature current will reverse the booster polarity to $+A_2, -A_1$ and it will run as a motor. Its purpose is to control the value of the total armature voltage by absorbing part of it. The regulator polarity will change from $+A_2, -A_1$, to $+A_1, -A_2$. The direction of booster field current is changed to $+F_2, -F_1$.

During the rest of the acceleration period the booster fluctuates about a low voltage to control the total armature voltage for constant current. For that matter, the booster will assume any voltage necessary to maintain constant back tension during the rest of the rolling period, whether operating at line speed or decelerating. Near the end of the deceleration period when the emf approaches the original value of booster voltage, the booster voltage will pass through zero and begin to build up in the other direction, polarity $+A_1, -A_2$. Another transition begins which is carried out smoothly with the booster voltage increasing as the emf of the motor decreases. Constant current is maintained at all times. Regulator polarity is $+A_2, -A_1$, booster field current direction is $+F_1, -F_2$. Finally at the instant of stopping, the booster is supplying all of the armature current and running as a generator.

The inertial torque compensation for the entry tension device is to relay the WR^2 field into operation $+F_8, -F_7$ during acceleration to decrease the regulated value of current. The WR^2 field increases the value of regulated armature current in deceleration by being relayed in a $+F_7, -F_8$ condition.

The threading provisions are the same as in the case of the delivery tension device.

DELIVERY REEL

Obviously, the delivery reel has to slow down with coil build-up to maintain constant peripheral speed. Also, it has to run at any one of four successively higher speeds to correspond with the line speed of the mill. Total speed regulation for the delivery reel is approximately 8.5 to 1, 3.6 to 1 by field weakening and 2.35 to 1 by variable voltage. The field weakening range is 3.6 to 1 for any of coil of 62-in. outside diameter at any line speed, while bus voltage will be approximately 40 per cent full voltage at 1275 fpm, 50 per cent full voltage at 1600 fpm, 80 per cent full voltage at 2400 fpm and full voltage at 3000 fpm, top line speed. After acceleration to any line speed, the bus voltage remains nearly constant during the coil build-up with a slight decrease of bus voltage during the complete winding of the coil.

Contrary to the case of devices on the common bus, a different value of current is held constant for different line speeds and tensions. Because, the entire range of field weakening is used for the speed regulation, therefore, for higher line speeds and lower tensions, the regulated value of current is lowered. This is accomplished by a rheostat in the control field loop of the supporting generator's regulator. The regulated value of armature current is increased by raising resistance in the control field loop. Then a higher valued IR drop is needed across the interpole to balance the reference field. Similarily, "Speed Calibrating" resistance is introduced in the control field loop of the motor field regulator by speed selecting contactors S_2, S_3, S_4. The delivery reel motor field regulator is a so called "Counter emf" regulator. It operates on the principle of having the control field and reference field nearly in balance at all times. So, for increasing armature voltages at increasing line speeds, resistance is introduced to keep the control field —NI at a nearly constant value.

The M.O.R. steadily increases resistance in the counter emf regulator's control field loop during acceleration to keep a near constant value of control field excitation with increasing values of counter emf.

IR drop compensation is added for the purpose of making a correction in the regulator's operation at different tensions. The counter emf regulator depends upon a direct measure of counter emf for smooth, accurate operation. The control field loop reference voltage is raised when the delivery reel armature IR drop increases, and the saturable reactors lower the reference transformer's primary impedance.

When the reels are first placed in stall tension, contactors "DR" and "DG" close and "ST" T.D.O. starts timing out. The voltage build-up of the motor field regulator is limited by the action of the volt limit field $+F_8, -F_7$. The supporting generator regulator builds up to a low voltage, high enough to just supply the IR drops of the motor and generator. This voltage is limited by the interpole IR drop in its regulator control field loop. In both cases the reference fields are balanced: and the self excited fields furnish the necessary excitation. As acceleration begins, a counter emf begins to appear across the delivery reel armature. This, together with the increasing M.O.R. ring resistance in the control field loop will lower the control field NI of the counter emf regulator. For the present, this excitation is $+F_5, -F_6$. Initially, the regulator's output voltage had to rise above the limiting value set by the "tap" controlling the volt limit field through "ST" T.D.O. in order to supply the volt limiting excitation. Counter emf of the reel armature soon builds up to where the control field excitation has gone from +NI through zero to —NI, $+F_6, -F_5$. Now, as the control field NI is changing, the volt limit excitation is gradually decreasing until the regulator voltage is exactly equal to the compared voltage determined by the tap. Then, the volt limit excitation is zero and "ST" T.D.O. opens. The reason for "ST" T.D.O. being in the circuit is to prevent the regulator from building up too high a voltage initially before the counter emf of the reel motor has build up sufficiently to furnish control field

excitation. Otherwise the reel would be sluggish in starting and a loop would be thrown between the delivery tension device and delivery reel. The control field NI remains nearly constant decreasing slightly as the coil begins to build up. Regulator voltage increases during this interval and the self excited field builds up. A gradually increasing regulator voltage and delivery reel field strength has occurred during the transition from opening "ST" T.D.O. throughout the acceleration. Small increases of field strength compensate for the added mass of the first coil wraps.

The action of the supporting generator voltage during this time has been to steadily increase until approximately 40, 50, 80 or 100 per cent bus voltage has been reached. As the reel is in motion from stall tension, the counter emf increases and lowers the armature current. This disturbs the balance between control field $-NI$, $+F_6$, $-F_5$ and reference field $+NI$, $+F_3$, $-F_4$, of the supporting generator's regulator. Then, regulator and generator voltages increase. As soon as the armature current has reached its normally regulated value, the interpole drop in the control field loop is high enough to balance the reference field. The generator voltage remains constant for an instant. The reel speeds up enough to raise the counter emf again and the armature current decreases. Generator voltage increases and is stabilized when control and reference fields balance. This process is repeated in a step by step manner until line speed is reached.

After acceleration, the reel's field strength will steadily increase with increasing coil build-up. Each change of coil diameter will require that more torque be exerted by the delivery reel. This in turn will increase the delivery reel armature current as it tries to assume an increased load.

The interpole drop in the supporting generator's regulator field loop will increase, decreasing the output voltage of the generator. Armature current of the delivery reel will return to its normally regulated value and the supporting generator voltage will stabilize for an instant. Decreasing the supporting generator voltage will decrease the control field NI, $+F_6$, $-F_5$ of the counter emf regulator. Regulator voltage will build up and increase the delivery reel motor field excitation. The next increase of current will decrease the generator voltage slightly and lower the counter emf of the delivery reel drive. The field of the delivery reel drive is progressively strengthened as the coil builds up. A decrease in bus voltage of 6 to 8 volts during the coil winding operation indicates that the motor field is being strengthened by the counter emf regulator. Near the end of the coil, the self excited field has increased excitation until the regulator voltage almost equals the excitation bus voltage. The decreasing re-

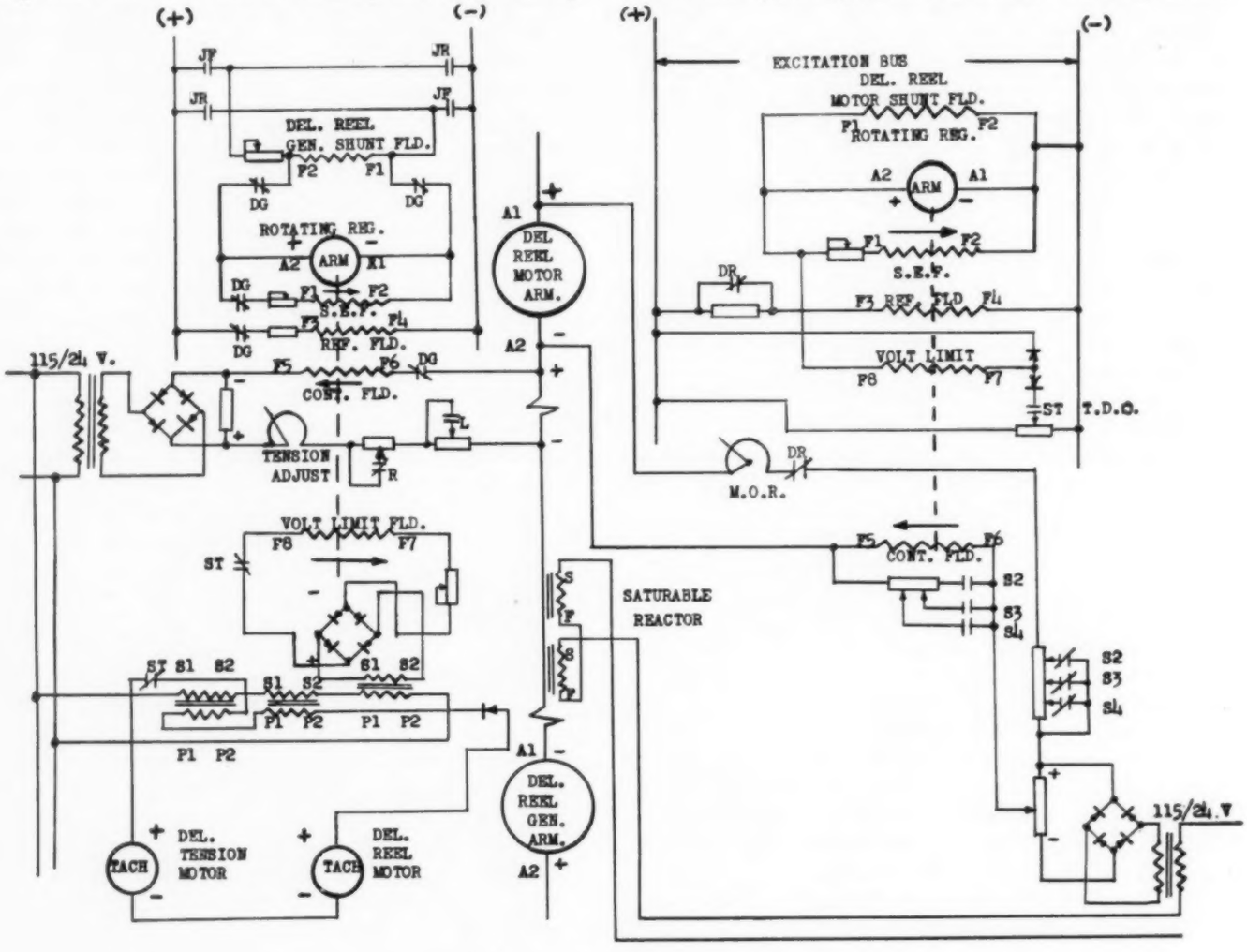


Figure 4 — Delivery reel control.

sistance of the M.O.R. ring in the counter emf regulator control field keeps the control field excitation at a nearly constant value during deceleration. There is a small unbalance in which the reference field predominates, just enough to keep increasing the excitation and voltage of the regulator. This will gradually strengthen the reel motor field during the deceleration period. Finally, at stall tension, the counter emf regulators output voltage will nearly equal the excitation bus voltage. The volt limit field will prevent the regulator voltage from increasing above excitation bus voltage.

The supporting generator voltage will decrease during deceleration. As the reel is slowed down initially, the counter emf of the reel drive will drop and the armature current will increase. The higher IR drop in the generator regulator control field loop will decrease regulator voltage. It in turn will decrease the supporting generator excitation and voltage. This process continues until the reel is down to the low voltage of stall tension. The reel is taken out of stall tension by pressing the "Stop" button which opens contactors "DG" and "DR," closes contact "ST" T.D.O.

Inertial torque compensation is accomplished by inserting resistance in the generator regulator control field loop during acceleration, to increase the regulated current value and torque; and shorting out resistance in the same control field loop to decrease current and torque during deceleration. These provisions are shown as fixed resistors controlled by single contactors "R" and "L" in Figure 4. Actually, these provisions are far more complicated. In reality they are networks of resistors and contactors. There is a different regulated current value for each line speed, and the resistors controlling inertial torque compensation for accelerating to different speeds have different values.

The special speed limiting circuit on the delivery reel serves two purposes.

1. To prevent the delivery reel from running away in the event of strip breakage.

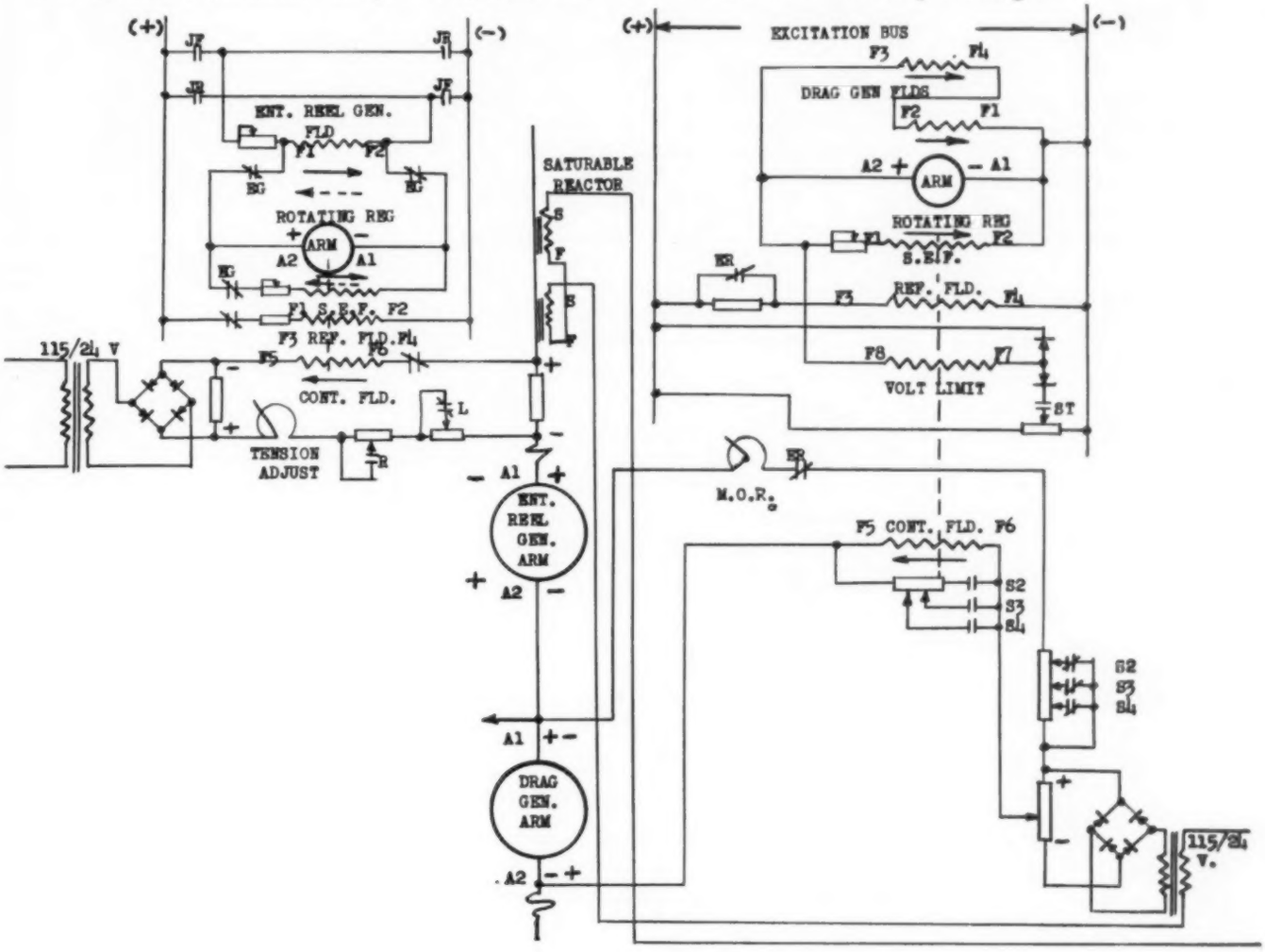


Figure 5 — Entry reel control.

2. To limit speed when belt wrapping is used to start the coil.

"Belt Wrapping" the first wraps of a coil under conditions of normal tension operation would be nearly impossible without a speed limiting circuit.

A tachometer driven by one of the delivery tension motors is in opposition to a tachometer driven by the delivery reel motor. If the delivery reel motor overspeeds, a saturable reactor will decrease the impedances of two inductors in series with a transformer. The transformer will conduct and establish a "Volt limit" field $+F_8$, $-F_7$ that will lower the supporting generator voltage.

Threading provisions are made in a conventional

manner; by relaying the generator regulator out of operation exciting the generator "straight away" from the excitation bus.

ENTRY REEL

In many respects, the operation of the entry reel is similar to the delivery reel. Tension is adjusted in the same manner. Speed calibrating resistors are included in the drag generator's regular control field loop for the same reasons. The threading provisions are the same. The only dissimilarities are that the drag generator regulator begins functioning. The M.O.R. inserts resistance in the emf regulator's control field loop to hold a near constant control field excitation as the emf increases. During acceleration, the regulator voltage decreases slightly and decreases the drag generator's field excitation.

The supporting generator voltage supplies all of the armature current at stall tension. Supporting generator voltage being held down to the low value necessary by the IR drop of the armature resistor in the regulator's control field loop. The reference and control fields balance.

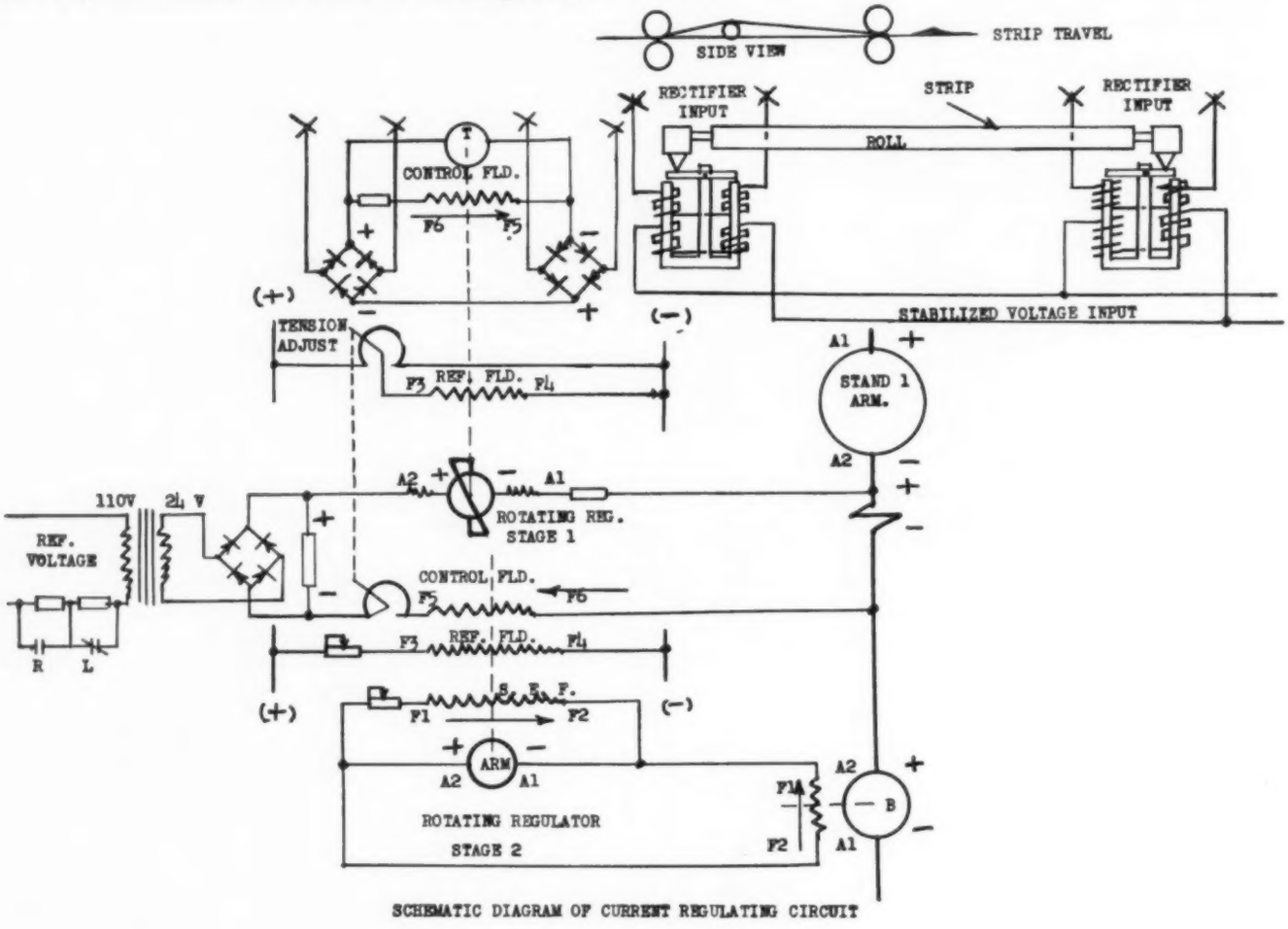


Figure 6 — Tension control for stands No. 1 and 2.

fields are weakened as the coil unwinds and that the supporting generator voltage is regulated at a value below the drag generator voltage to maintain a constant net difference between them. The method of speed regulation remains the same, by variable voltage and field weakening. The field weakening range will be 3.1 to 2 for any coil of 62-in. outside diameter. Bus voltage will be approximately 40 per cent full voltage at 1275 fpm, 50 per cent full voltage at 1600 fpm, 80 per cent full voltage at 2400 fpm and full voltage at 3000 fpm.

At stall tension, contacts "EG" and "ER" close and "ST" opens. Contact "ST" is used only to limit the build-up of regulator voltage when the mill is standing still. Its primary purpose is to act as an economizer. The regulator voltage builds up to nearly excitation bus voltage. If it tries to exceed excitation bus voltage, the volt limit field furnishes excitation $+F_8$, $-F_7$ to limit its output voltage. Soon after starting, the emf

As soon as the drag generators are in motion, their emfs begin to build up and their polarities reverse to $+A_2$, $-A_1$. Both begin to run as generators and to "aid" the supporting generator. The same sort of transition begins here as in the case of the entry tension device. The supporting generator voltage decreases as the drag generator's emf increases. Constant current is maintained at all times. When the drag generator emf equals the original generator voltage of stall tension, the generator reverses polarity to $+A_1$, $-A_2$ and begins to run as a motor. The generator's rotating regulator has had its excitation decreased by the action of small increases of armature current increasing the control excitation $+F_6$, $-F_5$. Control field excitation is increased by increasing the IR drop across the armature resistor in the control field loop. Regulator polarity changes to $+A_1$, $-A_2$. Generator excitation field current reverses to $+F_2$, $-F_1$, the reference field now acts

as a constant "balance." Further build up of drag generator emf produces small changes of armature current. In order to regulate for a constant value, the generator voltage will have to increase. Constant current is maintained during acceleration with the supporting generator voltage "tracking" increases of drag generator emf. Once line speed has been reached, the voltage stays fairly constant during the unwinding of the coil, with a slight voltage "rise" of 6 to 8 volts. This slight increase is an indication of the counter emf regulator operation.

When the coil unwinds during the line speed operation, the emf of the drag generators rise. This increases the armature current and the control field excitation of the supporting generators rotating regulator. Generator voltage will increase. Armature current is then correct to its regulated value and generator voltage will remain constant until the next increase of emf allows the armature current to rise and raise control field excitation. This will go on until the end of the coil. The drag generator's field excitation is weakened each time the emf rises and increases the emf regulator's control field excitation $+F_6, -F_5$.

When deceleration begins, the emf decreases. Armature current falls below its regulated value and the supporting generator's voltage drops until the armature current is corrected. Each successive drop in emf will lower the bus voltage until the bus voltage equals zero. Then the supporting generator's polarity will reverse and it will begin to run as a generator. The same transition is passed through as before, when starting up from stall tension, and the supporting generator is furnishing the armature current at the instant of stopping. The reel is taken out of stall tension when the stop button is pressed, contacts "EG," "ER" open and "ST" closes.

Inertial torque compensation is to decrease resistance in the generator regulator's control field loop, to decrease current and back tension during acceleration. Resistance is added to the loop to increase tension and current in deceleration. As in the case of the delivery reel, the resistors controlling inertial torque compensation are all dissimilar. Figure 6 merely shows a single resistance and single contactor "R" and "L."

STAND NO. 1 — NO. 2 CONTROL

Stand No. 1—No. 2 control schematic diagram shows the regulating circuit in a position to regulate for constant current or constant tension while running. Threading provisions are made by taking the first stage rotating regulator and the reference field of the second stage regulator out of operation. Then, the control field of the second stage is connected across a bridge circuit for a reference. Threading speed control works in the same manner as in the case of the two tension device threading controls.

Current is regulated by a two stage regulator in this case. The input to the first stage is the out-put of a tensiometer. Briefly, the tensiometer consists of a roll which the strip travels over; this roll is held in place by a cantilever spring. Increasing tension will deflect the spring, push the roll down and decrease the air gap of one side of a split core transformer with opposing windings.

As the flux density is greatly increased in the one side, the transformer conducts. One of these transformers is located at either side of the roll and feeds rectifiers in the control field circuit of the first stage rotating regulator. With these rectifiers placed in the circuit as "Aiding Batteries," there will always be current circulating in the control field winding of the first stage when there is any deflection of the roll. Altogether, the tensiometer input circuit to the first stage regulator is very sensitive and accurate. For example, the flux in the transformer core would be 2000 to 3000 times greater, if there were no air gap. Small changes in air gap produce large changes in flux, resulting in an accurate measurement of deflection or tension. There is a voltmeter connected across the control field of the first stage regulator to indicate tension between stands. Tension is adjusted by varying a potentiometer and rheostat that are connected together mechanically. The potentiometer changes the drop across the reference field of the first stage rotating regulator. This will change its output voltage. As the potentiometer raises the input voltage to the loop containing the control field of the second regulator, the rheostat will decrease resistance in the loop. This is to maintain constant control field excitation with decreasing "net" loop voltage.

The booster in this case is used to control the total armature voltage of Stand No. 1 motor, but this booster will be regulated at a definite voltage in order to limit the armature current of Stand No. 1. It will always be operated as a generator to increase the total armature voltage. Then, tension is raised by raising the booster voltage and lowered by decreasing the booster voltage.

OPERATION OF THE REGULATOR WHEN STAND NO. 1 IS USING MOTOR POWER

The first stage regulator reference field is set by the potentiometer. This determines the tension at which a balance between reference and control field or reference and tensiometer roll deflection will occur. When the stand is first energized and tension is applied between stands, the first stage regulator builds up in voltage until it is controlled and stopped by the control field. In this balanced condition, the first stage regulator's armature reaction serves as a self excited field. This output voltage is regulated by the deflections up or down of the tensiometer rolls which will produce a change of control field.

For the purpose of discussion, suppose the mill is being accelerated up to speed from stall tension, and for simplification, neglect the effects of inertial torque compensation. The driving emf on the second stage control field loop is furnished by the first stage input voltage and the interpole IR drop is compared to the loop reference voltage. When the bus voltage starts increasing, the tendency of the armature current is to exceed the regulated value. This value would be less than the inherent value because the armature current is to be regulated at a value below this in order to hold tension between stands. The interpole IR drop in the booster regulator's control field is greater than it will be at constant current. Therefore, control field excitation is less than the value needed to balance the reference field. The booster regulator's voltage will build up until the

armature current reaches the regulated value. A further increase in bus voltage produces another increase of armature current which leads to a lower control field excitation and allows the booster voltage to increase again. The booster voltage will track the bus voltage as it rises maintaining constant current at all times. Finally, when line speed is reached the booster voltage will assume a value that will regulate the total armature voltage for constant current. This booster voltage will be regulated at this value during operation at line speed in order to maintain a constant net difference between total armature and bus voltage. A decrease in tension would cause an increase in armature current which in turn would raise the booster voltage, and increase tension. Any increase in tension above the constant value would lower the booster voltage and correct the tension. In both cases, the correcting means would be in change of the second stage regulator's control field by changing the interpole IR drop. Upon decelerating the tendency would be for armature current to initially decrease. This would lower the booster voltage by increasing the second stage reference field excitation. This voltage would be stabilized instantaneously at regulated current. The next decrease in bus voltage would again decrease the armature current which in turn would lower the booster voltage. This will go on a step by step basis until the mill is decelerated, constant current and tension are maintained at all times.

OPERATION OF THE REGULATOR WHEN STAND NO. 1 IS NOT USING OR REGENERATING POWER

The regulator operation would be the same. Booster voltage would have to be maintained so that the total armature voltage would equal the bus voltage. Correction for an increase of tension would be reference voltage plus interpole IR drop vs first stage input voltage to furnish an increase of control field —NI (+) F_5, (—) F_6 and lower the booster voltage. If the tension decreases, polarities within the second stage control field loop would be; reference voltage vs interpole IR drop plus first stage input voltage. This would lower the control field —NI, (+) F_5, (—) F_6 and the booster voltage would increase.

OPERATION OF THE REGULATOR WHEN STAND NO. 1 IS REGENERATING POWER

Booster voltage would have to be maintained so that the total armature voltage is greater than bus voltage. This is a condition of higher tension than the other two. Therefore, the potentiometer controlling the drop across the first stage reference field will have to be adjusted until the value of the first stage input voltage to the second stage control field loop is high enough to oppose the reference voltage plus interpole IR drop.

The first stage input voltage will increase and the interpole drop will decrease. This will decrease the second stage control field —NI, (+) F_5, (—) F_6 and the booster voltage will increase. The first stage input voltage would decrease and the interpole IR drop would increase if the tension is increased. This would accentuate the difference between voltages and the control field —NI, (+) F_5, (—) F_6 will increase. The booster voltage would be lowered to correct the tension.

Provisions for inertial torque compensation are made by means of contacts in the primary of the 115/24 volt reference voltage transformer of the second stage control field loop. When accelerating, the contact "R" closes, lowering the transformers' primary impedance and increasing the drop across the resistor R_1, or the loop reference voltage. This will increase the second stage control field NI (+) F_5 (—) F_6 and lower the output voltage of the second stage regulator. This in turn will lower the booster voltage and decrease tension between stands. Decreasing tension in this case is synonomous with decreasing the dragging torque for the purpose of accelerating the mill. When decelerating, the contact "L" opens, increasing the reference transformers' primary impedance. The drop across R_1 decreases, lowering the second stage control field NI (+) F_5 (—) F_6 and increasing the output voltage of the second stage regulator. Tension between stands is increased for the purpose of decelerating.

SUMMARY

Control techniques used in the regulation of steel mill equipment are continually changing. One installation may be obsolete when compared to another made only a few years later. For instance, one recent development, the magnetic amplifier, has been employed by the same company that installed our two-stand temper mill. The magnetic amplifier has been used to both replace and supplement rotating regulators.

The method of control may vary for different temper mills, but the basis of control remains the same. This is true whether the regulating method is by mechanical-electrical regulators that compare the pull of a solenoid to a spring tension, by rotating regulators, or by magnetic amplifiers.

In the writer's opinion, it is necessary for engineers employed by steel companies to understand the complicated control systems that exist in their plants.

BIBLIOGRAPHY

1. "*The Temper Mill*," by T. B. MONTGOMERY, 1942 Proceedings of the AISE.

2. "*Temper Mill Symposium*," 1952 Proceedings of the AISE.

3. "*Servomechanisms and Regulating System Design, Vol. I*," by HAROLD CHESTNUT and ROBERT W. MAYER.

DISCUSSION

PRESENTED BY

E. E. VONADA, Application Engineer, Reliance Electric and Engineering Co., Cleveland, Ohio

T. B. MONTGOMERY, Engineer in Charge, Control Division, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

F. E. FAIRMAN, III, Application Engineer — Steel Mill Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

A. J. WINCHESTER, JR., Application Engineer, Metal Working Section, Westinghouse Electric Corp., East Pittsburgh, Pa.

E. E. Vonada: This paper is one of the most complete studies and analyses of a temper mill rolling system that has been written. Such studies will enable the steel

mill engineer to better evaluate the equipment being proposed for new drive installations, both from the dollar and flexibility standpoint.

T. B. Montgomery: The paper suggests a number of points that might be the basis of discussion. One topic is the acceleration of the mill. The paper lists two methods. The first is accelerating over the lower part of the speed range, by raising generator voltage with full field (approx) on the motors. Speeds higher than those corresponding to full generator voltage are obtained by motor field weakening. This operation is used on blooming mills, and has been tried on tandem mills. It has the advantage of providing maximum torque/ampere at all speeds and results in minimum accelerating times. It has the disadvantage that the time constant of motor fields as well as generator fields enter the regulating problem. Although it is possible of accomplishment, regulating equipment becomes more complicated. I do not know of a modern temper mill operating in this manner. The second method is acceleration with preset motor fields, which is conventionally used.

A second topic is that of varying inertia constants. Perhaps more attention should be given to this in the higher speed mills, when acceleration may be made to say, one-half speed at one setting of top operating speed (full motor field on a 2 to 1 speed range motor), to three-quarter speed at another setting and to full speed at another setting. This author has listed four top rolling speeds, 1250, 1600, 2400 and 3000 fpm. If the mill accelerates to 3000 fpm in 15 seconds, for the compensation for inertia to be correct, it should accelerate to 1250 fpm in $15 \times \frac{1250}{3000} = 6.25$ seconds or else the control need change the inertia compensation during acceleration and deceleration accordingly.

Another item is the matter of unequal tensions between the top and bottom rolls of the delivery tension device. I do not remember the ratio used in operation on this particular mill. However, we all recognize that securing the desired delivery tension is intertwined with the mechanical problem on the tension rolls. Perhaps you will comment on your experience.

As to control techniques, particularly those used in later mills, we all appreciate that the goal of the manufacturers is to improve the components of the regulating systems. This is evidenced by much discussion in the association with papers on magnetic amplifiers, and their growing use, versus other types.

With a look to the future, considering these mills from the standpoint of overall control, I believe we will be able to follow the trend in recent years of more closely tying the control of tension and roll work to the metallurgy of the strip; in other words with the effectiveness of the processes ahead of the tempering process.

F. E. Fairman, III: It is readily seen from Mr. Dirth's paper, which discusses the details and complexities of a modern two stand temper mill, that the engineering of temper mills requires an integrated system type of approach. The particular type of control scheme used depends to some extent on the type of generator arrangement used.

Obviously, as Mr. Dirth pointed out, the individual generator arrangement provides the utmost in flexibility. However, there are a number of mills in operation using a common bus with boosters in order to take advantage of load diversity. By making full use of the pumpback power, the total generating capacity can be reduced and the initial equipment investment cut down. The subject of common versus individual generators has been touched upon in several papers before the AISE. Before selecting generator capacity and arrangement, careful consideration should be given to the basic electrical control scheme to be used, accelerating rates, products to be rolled, mill operating practice, and future trends in the steel trade.

The temper mill control which Mr. Dirth has analyzed shows a number of rotating regulators being used. Regulating control systems on temper pass mills are very similar to those used on cold reduction mills. It is expected that the same trends will be followed in regulating system design with some rotating regulators being replaced by magnetic amplifiers. In fact, a two-stand temper mill scheduled to go into operation shortly has approximately the same number of magnetic amplifier units as rotating amplifier regulator units. It is believed that the combination magnetic amplifier rotating amplifier system is the simplest, most reliable system to suit the requirements of the temper mill.

A. J. Winchester: Sometimes in a major expansion program involving tandem cold mills and hot strip mills, there is a tendency to minimize the importance of and overlook what it takes to make a successful temper mill. As an ex-control engineer, I am well acquainted with the complexity of temper mills. Once when I was assisting our service engineers at an installation, one of our executives made a routine visit to the site. I reviewed briefly what we were doing and showed him a copy of the schematic diagram. He shook his head and said, "I had no idea that the equipment involved is so much or so complicated. Why this is more complicated than a tandem cold mill!" And this is often the case.

Simplicity is one of the points which our control engineers hold constantly before them. Make the control as simple as possible. If the requirements of the application can be met with one rotating regulator, do not use two. If the requirements can be met without any regulators, do not use any regulators. We find that this policy pays dividends; our customers are grateful, because their maintenance job is easier.

We believe that current regulation is best obtained by operating with the regulator through a constant speed machine, a generator or a booster generator. You cannot maintain current by regulating the field of a motor when the armature of that motor is at a standstill, and it is necessary to maintain stalled tension on temper mills.

Mr. Dirth describes a system for regulating strip tension between the stands of a two-stand mill. We have developed for this application a regulating tensiometer which utilizes magnetic amplifiers and is in operation on an installation. This tensiometer requires no mechanical damping or source of air pressure. The force proportional to strip tension is obtained by deflection of a cantilever beam. By using magnetic amplifiers which are excellent in that they are static devices, we feel that we have made a notable advance in the art.

AISE Pictorial Review

1954 Annual Convention

and

Iron and Steel Exposition

Steelmen from all parts of the world converged on Cleveland, World Series and all, to attend the 48th Annual AISE Convention and Iron and Steel Exposition. More than 13,000 registrants crowded through three halls of the Public Auditorium to view the wares of 185 exhibitors who utilized 411 booths.

The election of John H. Vohr as president for 1955 and the establishment of district sections of the AISE in St. Louis and on the West Coast were announced during the convention.

Substituting for Eric L. Anderson, who was ill, vice president John H. Vohr (1) officially opened the four-day meeting.

The authors and chairmen of the various technical sessions gathered each morning to discuss papers to be presented. C. F. Peck, Jr., N. A. Hansen, Wade Hoffman and E. J. Vanderploeg (2) make final plans for the Rolling Mill session. In (3) F. C. Weir, C. W. Bruce, H. E. Degler and E. C. Hite (seated) discuss the Mechanical session with J. C. Lantz and C. V. Batley, while in (4) A. B. Glossbrenner, T. E. Perry and S. O. Evans (seated) make final arrangements for the Operating Practice session with R. J. Garmey, G. I. Bottcher and J. F. Black. The technical sessions, (5) held in Club Room B and the Ball Room of the Auditorium, featured 48 papers by Steel Mill authorities on all phases of steelmaking.

A program of social activities (6) entertained the AISE ladies who attended the convention.

The many exhibits on display at the various booths drew keen interest from those attending the show. At the Gulf booth (7) J. N. Wognum, W. E. Irvin, Jr. and T. J. Fullerton of Acme Steel Co. discuss hydraulic pump lubrication with T. H. Messer, Gulf Oil Corp. R. F. Lucas, Weirton Steel Co., (8) listens attentively while John Bangert, Crouse-Hinds Co., describes the features of an explosion-proof hand lamp. A. J. Macer, Jr., (9) Ajax Flexible Coupling Co., explains the operation of a model coupling to F. A. Baker, Jr. and P. H. Pangburn of Bethlehem Steel Corp. Demonstrating the Electric Controller and Manufacturing Co. master switch (10) is P. J. Kelley of EC&M as F. J. Maher, Formweld, and O. M. Schulze, Republic Steel Corp., look on. Exhibits of Chandeysson Eletric Co. (11), Koppers Co. (12), and GE (13) were several of the booths that attracted keen interest.

In (14) James Farrington, founder of the AISE, congratulates John H. Vohr, president-elect for 1955.

C. C. Wales chats (15), with V. H. Leichliter and J. L. Young at the reception which preceded the banquet (16).

1

7

8

COUPLING
9

10

ELECTRIC COMPANY. ST. LOU
11

KOPPERS ENGINEERING AND CONSTRUCTION
CONTINUOUS CAST
12

13

14

15

16

Processing and Drawing of Steel Wire

By P. A. BEAMAN
Manager, Wire Machinery Dept.
Morgan Construction Co.
Worcester, Mass.

. . . . wire drawing is one of the oldest processes in the steel industry . . . . it still presents a challenge to the operator in his attempts to produce quality and strength . . . .

▲ WIRE is an ancient form of metal. The date of the earliest production of wire is lost in the dim pages of ancient history. It had an early beginning as samples of wire are found in the tombs of the Pharaohs in Egypt. These early samples are of rare metals and were used for decorative purposes. It is probable that they were produced by hammering thin strips sheared from a plate. Wire was used in chain mail in the Middle Ages and very likely was produced by the same process.

The date of the first use of the wire drawing die is not accurately documented but it probably occurred at least 600 years ago. In the intervening years there has been no change in the basic process. Wire is still made by drawing it through a tapered hole in hard material. The early wire drawing industry in this country was principally for the production of wire for sewing needles, knitting needles and for making cards for combing flax and wool. This small start was given a heavy impetus during the 1850's and 60's caused by the invention of the electric telegraph and by the demand for fencing for the rapidly developing West. It has had steady growth since that time until it is now an industry which converts about 6,000,000 tons of steel per year.

Some of the major classifications of wire and their annual tonnages are as follows:

Fence, including barbed and field fence, 400,000 tons.

Wire nails, 750,000 tons.

It is interesting to note that both of these items are a declining market. Both attained their maximum tonnage previous to World War I when their output was about 1,500,000 tons each. At that time fence had an expanding market as land was being taken up in the West. It is now a replacement market. The tonnage of nails has dropped on account of the substitution of fiber cases for wooden shipping boxes and the change in construction from individual houses to apartment dwellings. But other wire requirements have increased to take their place. Additional items are:

Insect screen cloth, 35,000 tons.

When we consider that the finished wire used in screen cloth is nearly ¾ of a mile per pound and requires over 20 drafts from the rod, we can see that a mill making 300,000 pounds a week of screen cloth has handled many miles of wire.

Fastenings such as bolts, screws and rivets, 900,000 tons.

Welded mesh, 320,000 tons.

The high carbon products are principally as follows:

Rope, 270,000 tons.

Mechanical and seat springs, 190,000 tons.

The remainder of the 6,000,000 tons is used in a thousand and one different items which are components of machines and parts of many different devices.

In making this production, the wire industry uses practically all grades of steel drawn into sizes roughly in the range between 1-in. diameter and 0.001-in. diameter. Most of the wire is cylindrical although shapes are also drawn.

The raw material of the wire industry is hot rolled wire rods produced in sizes something over 1-in. diameter as the largest and No. 5 as the smallest. The principal use of the larger size rods is for coarser sizes of wire for bolts, chain, manufacturers wire and numerous other specialties. All of the finer sizes are drawn from No. 5 rods which are $\frac{7}{32}$-in. (0.218-in.) diameter.

No very plausible explanation has ever been offered as to the reason for selecting $\frac{7}{32}$-in. diameter as the

size of the wire rod. It has long been established by custom and probably will remain the standard size for long years to come. It is doubtful if it will ever be made smaller on account of increased cost and the difficulties in producing a smaller gage rod on a rod mill. Any change is likely to be towards a larger diameter whenever it can be proved that additional reduction can be drawn cheaper than it can be rolled.

There have been steady improvements in the raw material for wire drawing over the years. Better quality of steel is being produced. Heavier coils and rods of more uniform cross section are being rolled. The earlier rod mills produced 150-pound rod coils. No. 5 rods are now being rolled in 600-pound coils with heavier coil weights projected.

After the hot rolled rods are delivered to the wire mill, the first process is cleaning or pickling to remove the rod mill scale and other surface imperfections. This is accomplished by immersing the rods in a 4 per cent solution by volume of sulphuric acid in water heated to about 180 F to which an inhibitor has been added. The length of time of pickling varies with the condition of the rod but it usually takes about twenty minutes. After removal from the acid, the rods are washed and then dipped in either a hot lime solution or in a borax solution depending on the type of coating the mill uses. If they are dipped in lime they are generally put through a baker to dry the coating. A borax coating will dry at room temperature. The baker also performs a function of driving out occluded hydrogen which has been released by the chemical action of the sulphuric acid on the steel, although the best of today's practice is dependent on the use of inhibitors to keep the steel from picking up the hydrogen rather than in the use of bakers to drive out the hydrogen.

Much experimental work is being done at the present time on mechanical cleaning of rods at the wire drawing machine with considerable promise of success on many types of products. The elimination of a cleaning house is a goal worth much effort to attain.

After the rods are cleaned they are ready for drawing.

The prime element in drawing is the wire drawing die. The wire drawing machine serves only to make the die effective. The wire drawing die has been aptly described as being outstanding among all the mechanical devices employed by man in that it presents a very remarkable combination of simplicity and effectiveness. It causes plastic flow of metal to give elongation and reduction in diameter to a degree obtainable by no other known method. It increases the tensile strength and the elastic limit of metal and, in combination with heat treatment, gives to steel the desired combination of strength and toughness not approximated by any other tool or process. It gives the wire a degree of accuracy of size and section otherwise impossible to obtain. It imparts to the metal a dense structure, a hard surface and a high degree of polish. It acts as an automatic testing machine detecting flaws in the metal, announcing them in no uncertain terms. It performs all of these functions simultaneously and with no other aid than a straight pull which is the simplest application of force.

In years past, numerous metals have been used for wire drawing dies. Among the ones in widest use were high carbon alloy steel and chilled iron. Of these chilled cast iron survived the longest for drawing the larger sizes of wire in the tonnage items. Today tungsten carbide dies have practically supplanted all other materials 100 per cent. About the only remaining use for steel dies is for small tonnages of special shapes where the cost of the tungsten carbide die is not justified.

The tungsten carbide die is a nib of tungsten carbide mounted in a metal holder. The hole in the die is polished to the proper diameter by an abrasive with the length of bearing and the angles of approach held to close limits in accordance with established mill practice.

On the wire drawing machine, the tungsten carbide die is generally mounted in a holder through which cooling water is circulated to reduce the temperature of the die. This increases its effective life.

The tonnage a tungsten carbide die will produce at any given size varies considerably with the grade of steel being drawn and the permissible size tolerance in the wire. When drawing low carbon wire with the usual mill tolerances, productions up to 200,000 pounds per die are expected. The die can then be polished out for the next larger size and a like service expected. The polishing can be repeated until the die is completely worn out. When drawing high carbon products to a close tolerance, much less tonnage is obtained from a die.

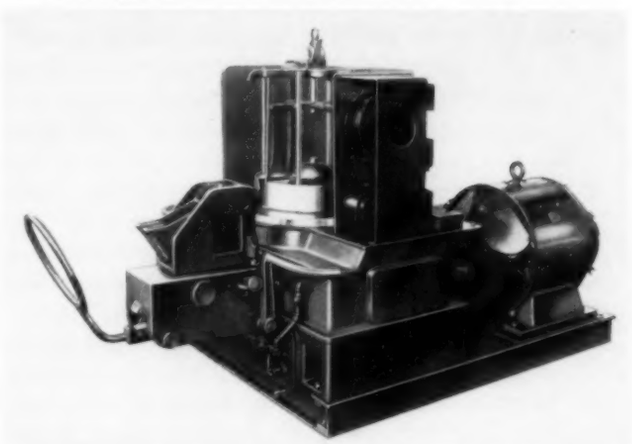
Diamond dies are used to a limited extent on fine sizes of wire.

The die box on the wire drawing machine holds the lubricant for the die.

The machine for making effective use for the wire drawing dies is the wire drawing machine. The same type of machine is used for drawing both high carbon and low carbon wire, but the different grades of wire will introduce considerable difference in details of speed of operation and horsepower to be applied.

Wire drawing machines can be put into two broad classifications, single block machines and continuous machines.

Figure 1 — Wire block machines are built normally with the spindle in the vertical position. They can also be obtained with a horizontal spindle.



The single block machine in common use today is a vertical spindle machine direct-connected to an electric motor and started and stopped by starting and stopping the motor. It is used on the complete range of rod sizes. It is sometimes equipped with a double-deck block so that two drafts can be taken simultaneously.

This type of machine draws a range of sizes requiring one or two drafts for a large number of miscellaneous uses. A few of the well known items are bolts, screws, rivets, chain, large nails and manufacturers specialties.

These machines are built in a wide range of speed, capacities, block diameters and horsepower. The drawing speeds may range from 100 to 200 fpm for specialties and special finished wire up to about 600 fpm for single draft work and 900 or 1000 fpm for double draft work. These maximum speeds in general are fixed by difficulties of unwinding the rods at higher speeds.

The rods for drawing are held on a reel on the larger sizes and on a reel or flipper in the finer sizes. The reel probably needs no explanation. The flipper is a device which holds the coil in a stationary position on approximately horizontal arms. The rod is flipped convolution by convolution from this device as required by the wire drawing machine. Its advantage is that the coil is stationary so when the wire drawing machine is stopped there is no tendency for the coil to overrun.

The finished coil is removed from the block by a collapsing stripper which is entered in slots of the block after the wire is drawn. Butt welding is not practiced generally on single spindle machines unless heavy weight coils are required, as less time is consumed in pointing and starting a draft than in welding.

A pointer is provided for reducing the diameter of the end of the rod for insertion through the die. A grip which is removably fastened to the block attaches to the point for starting the draft.

These machines are also built in smaller sizes for use on finer sizes of wire which require one draft after a heat treating point.

The horsepower of the motor applied to these machines in general varies between 15 or 20-hp for the small sizes up to 200-hp for the large sizes.

Single block machines are also built with the block spindle in a horizontal position. On wire ½-in. diameter and larger, a horizontal machine is a superior machine to the vertical spindle machine on account of the ease and rapidity with which the wire can be stripped from the block. After the back end of the coil goes through the die, the recoil of the wire loosens all the convolutions on the block so the wire coil is easily removed to a hairpin hook.

A single block machine drawing from heavy weight rod coils will produce 3,000 to 4,000 pounds of wire per hour depending on the size range.

Wire requiring more than two drafts is drawn on a continuous machine. A search of the patent office records will reveal that since wire drawing became a major industry in about 1860, many attempts have been made to build a successful continuous wire drawing machine for steel wire. Practically all of the early machines were what are called slip type machines. These machines have a series of drums driven at fixed speed with the speed increasing towards the finishing end of the machine to partially compensate for the elongation. The wire is put through a die, given a few wraps on the drum, put through the next die, given a few wraps on the next drum and so on, until the finishing block is reached. No attempt is made at synchronization of the speed of the drum to the required speed of the wire. Therefore, there always has to be a slip between the drum and the convolutions of wire wound onto it. The heat produced by the slippage and the removing of coating on the wire caused by the slippage prevented this type of machine from ever being a major success on the larger sizes of wire. In spite of these limitations, many machines working on this principle are used today on fine sizes with wet lubricant.

The goal of the wire machine designer was always to produce a non-slip machine. He finally arrived. There are two types of machine on the market today which have found acceptance as non-slip machines.

One uses an adjustable speed d-c motor on each block with the speed of the blocks regulated by the tension of the wire between the blocks. The wire passes over a sheave on a swinging arm which regulates the motor speed.

The other machine is an accumulation type of machine on which each block removes the wire from the preceding block by uncoiling rather than by unwinding. This type of machine can be driven by either a-c or d-c motors.

On this type of machine each block is operated at a higher speed than the preceding block to nearly compensate for the elongation of the wire through the die. As the wire is uncoiled from the preceding block, the speed of the blocks is not required to be in complete synchronism with the elongation of the wire. Excess wire is accumulated on the intermediate blocks. The rate of accumulation is a function of the relative speed of the blocks and the reduction in area in the dies. Clutches are provided on the intermediate blocks so they can be stopped to run down the accumulation.

This type of machine gives ample time between drafts for adequate cooling. It requires no special arrangement or complicated devices for producing non-slip operation.

Some type of cooling is required on continuous machines to reduce temperatures to a safe limit and maintain die lubrication. On high carbon wire, cooling is necessary to preserve physical properties.

The acceptance and wide use of these continuous machines was much fostered by the introduction of the tungsten carbide die during the early 1930's. With tungsten carbide dies, truly continuous drawing can be obtained by butt welding of the succeeding rod coils, so the machine does not have to be rethreaded during the life of a set of dies.

The conventional continuous wire drawing machine has drawing blocks in a straight line mounted on a suitable frame. A die holder or die box is provided for each block. The last block or finishing block is de-

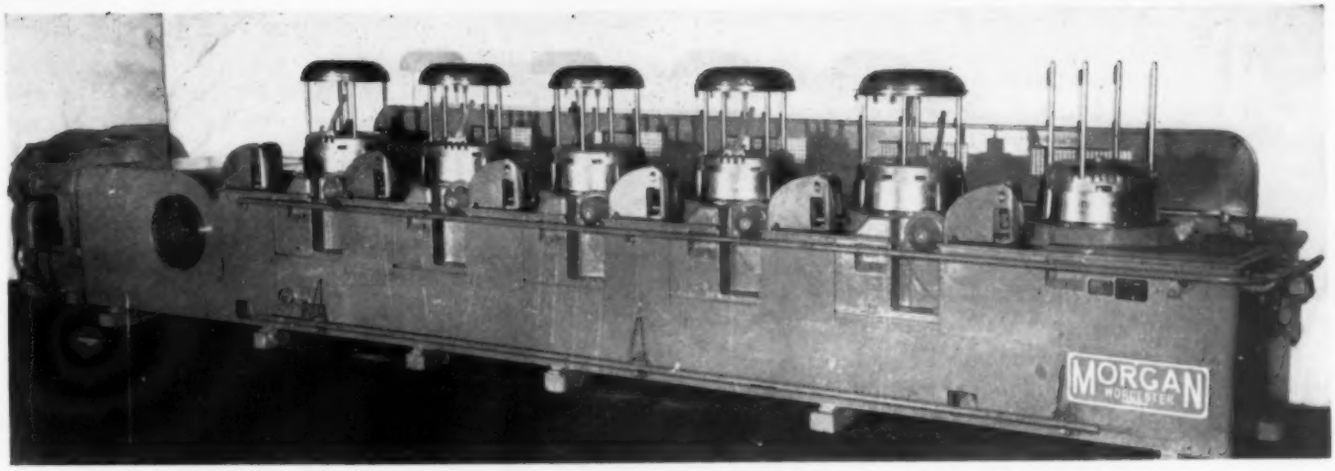


Figure 2 — Developments in die materials have lead to advances in continuous drawing.

signed to accumulate the finished coil of wire. Safety devices are included to protect the operator. The magnetic control on the driving motor gives slow start, gradual acceleration and quick stop.

Continuous machines for drawing from the rod are built for the number of drafts required for the particular installation. The usual number of drafts fall between three and eight, with five and six the most popular numbers.

The overall reduction in cross-sectional area given the rods depends on the size of wire to be produced. If the goal is a fine wire, as for example 0.010-in. and 0.011-in. required for screen cloth wire, the No. 5 low carbon rods will be drawn to about 0.035-in. as the first step without an intermediate annealing. This means a total overall reduction in cross-sectional area of over 97 per cent. The individual reductions will vary from about 40 per cent for the first draft on the hot rolled rod to 25 per cent as the wire becomes work hardened.

The finishing speed of the continuous machine will depend on the number of drafts the wire is drawn with speeds up to 2000 fpm being used on wire given five or more drafts.

The horsepower of the driving motor for the machine depends on the size and grade of wire being drawn and the finishing speed. Continuous machines using up to 450-hp are in operation.

When drawing low carbon No. 5 rods, 5-drafts to 0.080-in. at 2000 fpm about 125-hp will be required on the machine, with about 80 kwh per net ton consumed.

The production per machine will vary depending on the size of wire being drawn, the speed of operation, the rod coil weight and finished wire coil weight.

The man's production also depends on rod coil weight and finished wire weight which determine the frequency of welding and stripping. These are the operator's principal servicing jobs. His usual work load is about 15 of these jobs per hour and equipment is assigned to him on this basis.

In general, drawing 0.080-in. wire from 300-pound coils of low carbon rods and stripping 300-pound wire coils, one man will operate two machines for a total production of 2000 to 2500 pounds of wire per hour.

An increase in rod coil weight and finished wire coil weight will increase the output of both machine and operator by reducing the down time of the machine and by reducing the number of servicing jobs required of the operator. These features will be discussed later in more detail.

The devices for holding the rods for drawing, the strippers for removing the finished wire from the block, the grip for starting the wire and the pointers are the same as described under single block machines.

Most of the previous remarks on continuous drawings have applied to low carbon wire in a carbon range 0.08 to 0.12 per cent C. The drawing of high carbon products in a carbon range from 0.45 to 0.90 per cent C is conducted in the same basic manner as drawing low carbon rods. Speeds for drawing high carbon wire, in general, are approaching those used for low carbon wire. More horsepower is required on account of the higher tensile of the material. One principal difference aside from capacity between low carbon and high carbon machines is the increased capacity of the cooling system required for high carbon wire.

All continuous machines are cooled. There is no metallurgical reason for cooling low carbon wire, but cooling is necessary to maintain lubrication on the wire and to secure long die life. On high carbon wire and especially on rope wire, a high degree of cooling is necessary. Unless the wire is cooled rapidly to a low temperature after leaving the die the twist test specifications on rope wire cannot be met. Late specifications on wire drawing machines as received from major producers of rope wire require that the wire be reduced in temperature to 200 F within 30 seconds after leaving the die. As the wire leaves the die with a temperature something in the order of 450 F a substantial problem is presented. These cooling specifications have been met by applying a large volume of cooling air to the machine. Late tests show wire temperatures of 150 F within 15 seconds after leaving the die. A 6-draft continuous machine driven by a 200-hp motor for drawing rope wire will have a cooling air fan driven by a 20-hp motor and delivering 18,000 to 20,000 cfm. Machines are on the market having air-cooling only. Other machines have water cooling on the interior of the blocks in addition to air-cooling.

The total overall reductions in rope wire are less than in low carbon wire. Rope wire is drawn generally about 85 per cent total overall reduction from the last heat treating point in 6-drafts with even reductions of about 27 per cent per draft. Hard drawn spring wires have higher overall reductions and higher reductions per draft.

Some of the high carbon specialties which do not run into high tonnage, notably music spring wire, will have a total overall reduction from the last heat treating point in excess of 95 per cent.

Continuous wire drawing machines for sizes finer than 0.020-in.. both in high carbon and low carbon wire are generally cone type slip machines with the wire drawn in a wet lubricant. The wire is wound on a block or on a spool. Drawing speeds on low carbon wire will be in the order of 3500 fpm with high carbon speeds much lower.

After wire has given a certain amount of overall reduction, it must be heat treated before drawing can continue. The point at which heat treating is required depends on the grade of wire and the specified physical properties of the finished wire. For low carbon wire, the heat treating process is annealing. This is done in closed pots in a controlled atmosphere furnace with the wire brought rapidly up to heat and a slow cool.

All high carbon wire is heat treated by a process known as patenting. Patenting is an individual strand heat treatment by which the rod or wire is pulled through a furnace heated to about 1800 F and rapidly cooled either in air or in molten lead at about 900 F. This heat treatment produces a wire of the proper structure for drawing and with tensile strengths up to 180,000 psi in 0.65 per cent C steel. For some requirements the higher carbon rods are patented before the first drawing commences.

On rods and the coarser sizes of wire, an open patenting furnace is used generally. On wire sizes 0.100-in. and smaller, a double lead furnace with the wire heated in lead and quenched in a second lead pan gives better temperature control. The wire or rods are run from reels and wound on blocks on horizontal spindles.

Other heat treatments are used to a limited extent. Some grades of cold heading stock are normalized before drawing.

The drawing process described above produces what is known in the trade as bright wire. Specialty wires require other coatings of which liquor finish copper coating is the commonest. Extra bright wire for plating is among the specifications. The wire mills are equipped to plate steel wire with different metal coatings.

The heaviest tonnage of coated wire is in zinc coated or galvanized wire. This finds its major outlet in field fence and barbed fence. As the wire to be made into fence must be annealed, all galvanizing units have an annealing furnace built in the galvanizing line.

Galvanizing is a strand process with the wire going through the annealing furnace, into the air to cool, through the different cleaning and wash tubs and into the molten zinc. As the wire leaves the zinc pan, it is wiped to remove excess zinc and then wound on blocks on horizontal spindles.

Other coatings, of which the commonest are tin and cadmium are used on specialty wires.

In addition to fence, the common products, wire mills also manufacture nails. These are made from bright hard drawn wire in many types and sizes.

A drawing operation similar to the wire drawing is conducted by the cold drawn bar trade. The basic principles are the same as in wire drawing except that in sizes 1-in. and larger, the product is drawn on a straight draw bench. Sizes smaller than 1-in. are block drawn, then straightened and cut.

Work is being done to produce heavier rod coils to increase the efficiency of the drawing machines. The rod mills are rolling heavier coils. The equivalent of heavier coils are produced by welding at the wire drawing machine or before delivery to the machine.

Devices are being developed to produce a heavier weight of coil from the wire drawing machine. The heavier weight coil has advantages in improving the efficiency of the wire drawing machine, and also the efficiency of a subsequent operation by reducing down time for threading.

Three methods of producing a heavy wire coil which are receiving attention at the present time are spools, fixed strippers and dead blocks.

Spools make an attractive package. They are easy to handle and give the minimum of difficulties in unwinding. However, the spooling machine and the spools are expensive. There is considerable upkeep on spools and the empty spools require considerable space for storage.

The fixed strippers are non-collapsing strippers to be used on the finishing block of a wire drawing machine and will carry up to a ton of wire on sizes 0.100-in. and coarser with less weight in the finer sizes. The stripper is removed from the wire drawing machine and transported to the next operation where it serves as a payoff reel.

The dead block is a device which holds the block stationary and the wire is wrapped on it by the die or tension device carried on a rotating arm. On this machine, the only limitation on the weight of wire coil is the life of the die which draws the wire to be wound on the dead block. There is, of course, a practical limitation imposed by the maximum coil weight which can be handled. The dead block does not have to be stopped to remove the wire from it. It is not subject to the speed limitations of a revolving block. The dead block has applications in other fields such as galvanizing and patenting.

Many other interesting items of auxiliary equipment are used by the wire industry.

The above are the highlights of an industry which to the novice must look simple. Basically, wire drawing is merely pointing a piece of wire and pulling it through a hole in hard metal. But with its problems on size, finish, tensile strength, toughness, elastic limit, torsion requirements and a multitude of other qualities, it has presented a challenge for many years to very capable men and will continue to do so for years to come.

APPLICATION OF MAGNETIC AMPLIFIERS

By ROBERT J. WEESNER, Assistant Chief Application Engineer, The Louis Allis Co., Milwaukee, Wis.

. . . . the magnetic amplifier is a device to be considered when selecting the components for controlling a mill drive . . . .

▲ IN order to have a common understanding of the term "magnetic amplifier," it is probably wise to start with what it is and how it operates. To do this simply, illustrations as well as words are necessary. Figure 1 shows the saturable reactor part of a magnetic amplifier. The change in language from a magnetic amplifier to saturable reactor may be puzzling. The magnetic amplifier is made up of a saturable reactor and a rectifier. The rectifier allows load current in only one direction. This uni-directional current aids in saturating the iron so that the magnetic amplifier requires less control power than the conventional saturable reactor.

A magnetic amplifier is a single direction device, in that it can increase or decrease the amount of power it will permit to pass, but it cannot decrease it to zero or reverse the output polarity. Figure 2 shows a characteristic curve taken from a magnetic amplifier of about 150 watts capacity, and shows how the output can be changed by regulating the ampere turns of the control winding. At the left, the power, which is permitted to pass through the magnetic amplifier, is a minimum, and at the right, it is a maximum. The fact that it does not reach zero at the left illustrates its single direction properties. Note that the control power is quite small in relation to the power it controls, and also note that both positive and negative ampere turns are needed to secure the entire range of output. The control range normally used is 10:1, although with more iron in the core, a 20:1 range can be secured.

Figure 1 — The magnetic amplifier consists of a saturable reactor and rectifier. Shown below is the reactor.

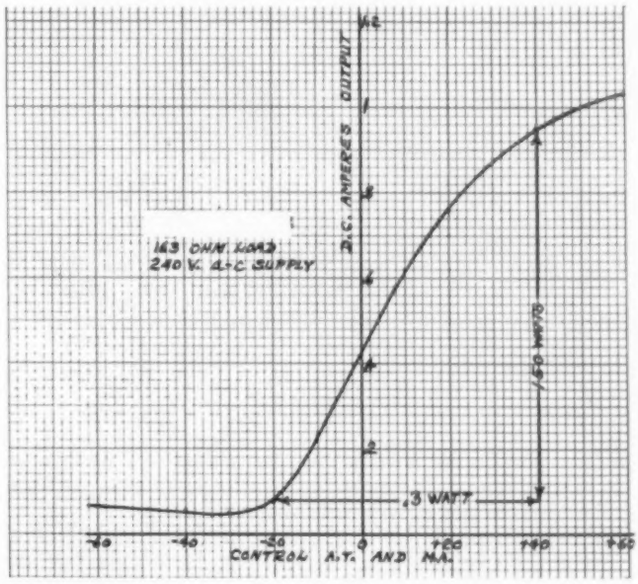


Figure 2 — Output is changed markedly by regulating ampere turns of control winding.

It is necessary to remember that in order to secure this full range of output from the magnetic amplifier, it must carry its full rated current when in the full turned-on condition. When applied to a load requiring magnetic amplifier output less than this, the range of the magnetic amplifier is restricted.

The curve is descriptive of the quantity of power, but not of the kind. The next curve, Figure 3, illustrates the kind of uni-directional voltage that comes through the magnetic amplifier at three different levels of output.

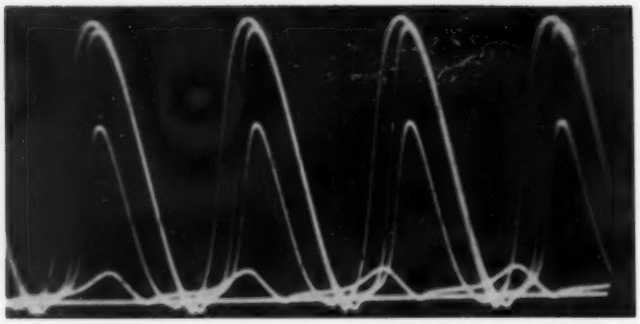


Figure 3 — Voltage is uni-directional.

The curve of largest amplitude is with plus 15 ampere turns, the next with 0 ampere turns, the next with minus 6 ampere turns, and the curve of smallest amplitude is with minus 15 ampere turns in the control winding. Area of the loop is a measure of output.

The output is similar to that obtained from a thyratron tube at comparable levels of output, but of a somewhat smoother wave shape. This leads to a better form factor than is usually obtained from thyratrons.

Once a device like the magnetic amplifier is developed, and its characteristics established so that we know what it will do, how it will act and what sort of power comes out of it, the next problem is where and how it can be used. There is more and more demand in industry for electrical devices that will reduce the amount of skill required of a human operator and increase the speed of the operation. The magnetic amplifier is one of the new tools that can be used for this purpose. It is not likely that the magnetic amplifier will ever replace all of the other similar devices, such as rotating amplifiers or electronic amplifiers. However, it makes its bid for consideration with several important advantages over these other types. It is entirely static and thus needs no bearings, brushes, brushholders or commutator. It is ready for use the minute it is connected to the power supply, with no delays for warming up. Its parts have a much longer life than electronic tubes. Its circuits are simple and readily understandable.

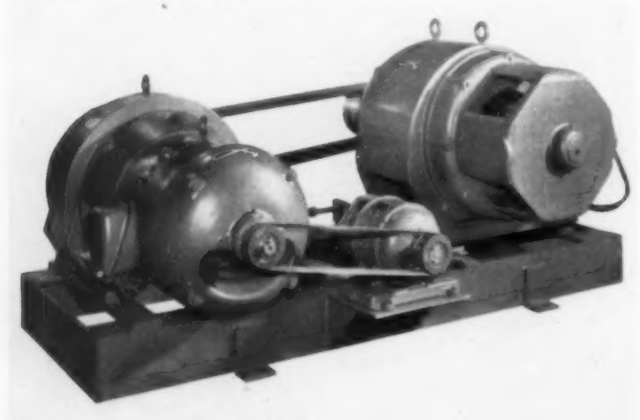


Figure 4 — To get adjustable high frequency, one typical setup uses adjustable speed motor driving an alternator.

An extremely rugged voltage regulator can be built, using magnetic amplifiers. While a very accurate regulator could be built, there is actually a large market for a less accurate regulator at a lower cost. One large field of application is the control of voltage in high frequency alternators. Higher frequencies than 60 cycles are frequently used to supply high speed grinder motors or woodworking motors. Formerly, a frequency converter has served this application at a higher cost to get a size that gave reasonably close inherent voltage regulation. Figure 4 shows a typical setup using an adjustable speed motor to drive an alternator in order to get adjustable high frequency. Using an alternator was formerly avoided because of its inherently poorer voltage regulation and the maintenance difficulties encountered with mechanical regulators.

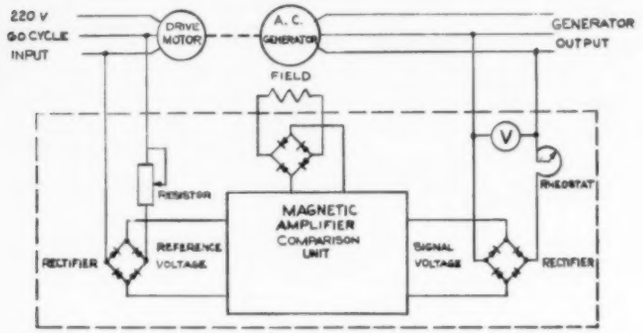


Figure 5 — Block diagram shows magnetic amplifier voltage regulator applied to alternator.

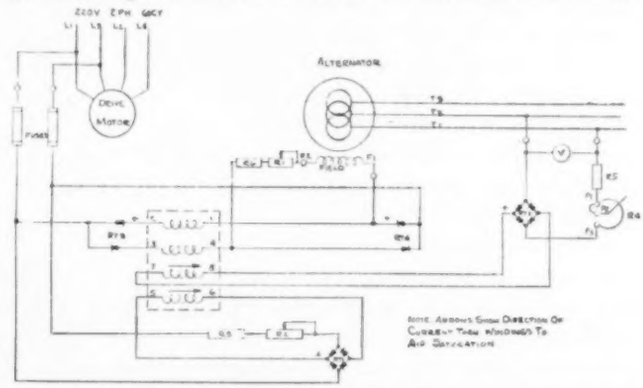


Figure 6 — Diagram shows circuit of alternator combined with a magnetic amplifier voltage regulator.

Figure 7 — Illustration shows completely assembled voltage regulator.

Often, an alternator, complete with magnetic amplifier voltage regulator, is less expensive than a wound rotor frequency converter, and yet it does a better job. Figure 5 shows a block diagram of the magnetic ampli-

fier voltage regulator applied to an alternator. A reference voltage, or benchmark, is obtained from a constant voltage transformer which is not shown, and a selenium rectifier. This voltage is used to establish a positive bias on the magnetic amplifier by the use of one winding for this purpose alone. The actual output voltage of the alternator is rectified and impressed on a second winding as a negative bias. With these control windings in opposition and the power windings connected to the alternator field, the regulator is ready for operation. When the alternator is not producing enough voltage, the positive bias reference turns the excitation on full, but when the output voltage matches the reference voltage, these two biases balance to hold just the proper excitation. Figure 6 shows an exact circuit and Figure 7 shows a completely assembled voltage regulator. A regulator of this sort is equally adaptable to a 60-cycle alternator or to a high frequency alternator generating power at 1000 or 2000 cycles or higher. This makes it very suitable for voltage regulation of an adjustable frequency alternator because it works equally well at all frequencies. Figure 8 is a test curve showing benefit derived by using regulator.

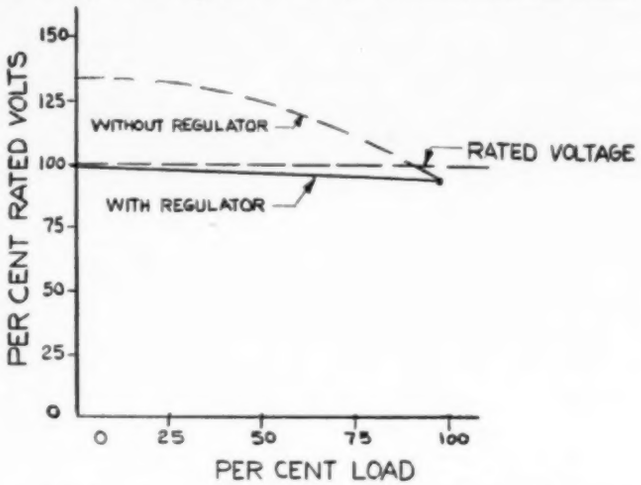


Figure 8 — Curve shows regulation of a 7.5-kva, 420-cycle alternator at 0.8 lagging power factor with and without separate regulators.

The magnetic amplifier is also being used to improve the operating results obtained from adjustable voltage

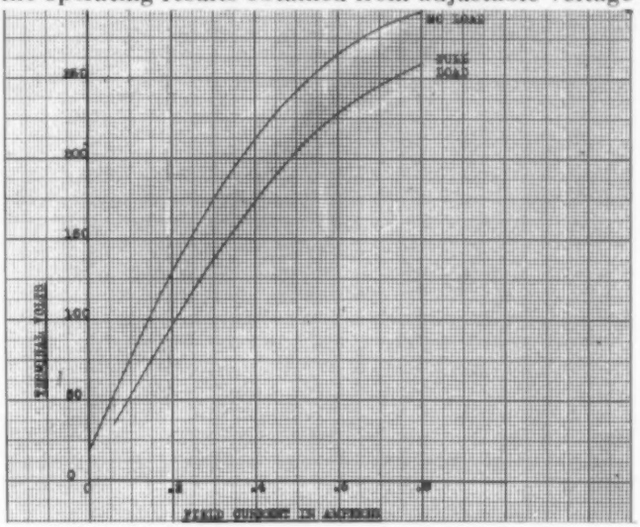


Figure 10 — Diagram shows no load and full load generator saturation curves.

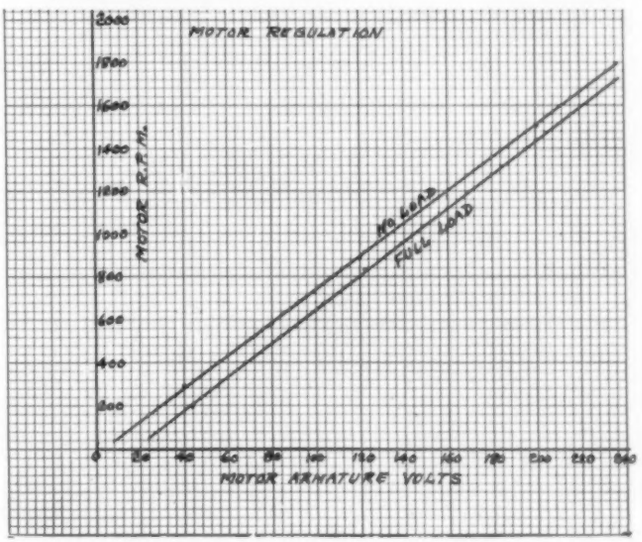


Figure 11 — Motor has a constant drop in speed with load.

Figure 12 — Motor has a rather large drop in speed with load.

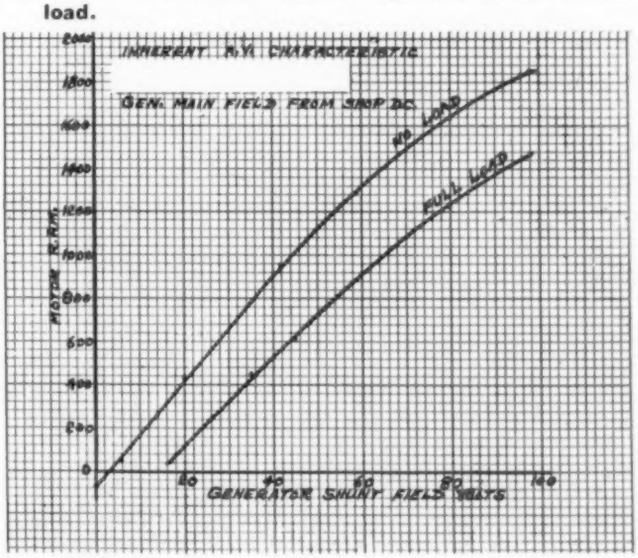
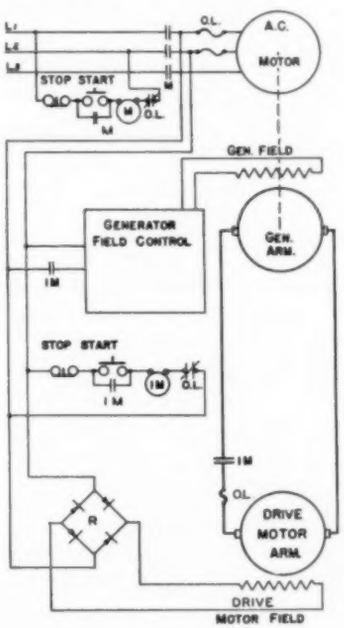


Figure 9 — One familiar form of speed control is obtained by supplying adjustable voltage to the armature of a d-c motor.



drives. Most engineers are familiar with the method of obtaining adjustable speed where adjustable voltage is supplied to the armature of a d-c motor and is raised or lowered to raise or lower the speed. A separate source of excitation is required for the fields of both the adjustable speed motor and the generator. This scheme, sometimes called the "Ward Leonard" system, has

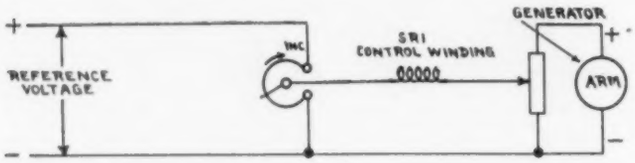


Figure 13 — Diagram shows circuit for excitation applied to generator through a magnetic amplifier.

been used for years and works well for large size units. In smaller sizes, design limitations keep the internal resistances of both the d-c motor and generator high. This is not particularly harmful at the faster speeds, where generator voltage is high, but at slow speeds, the

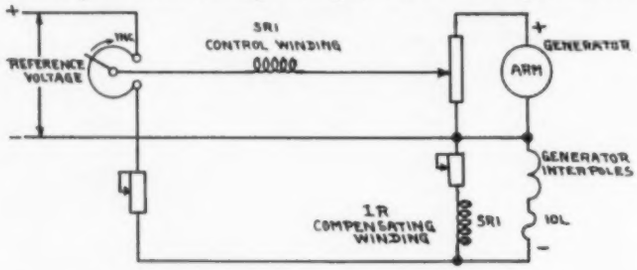
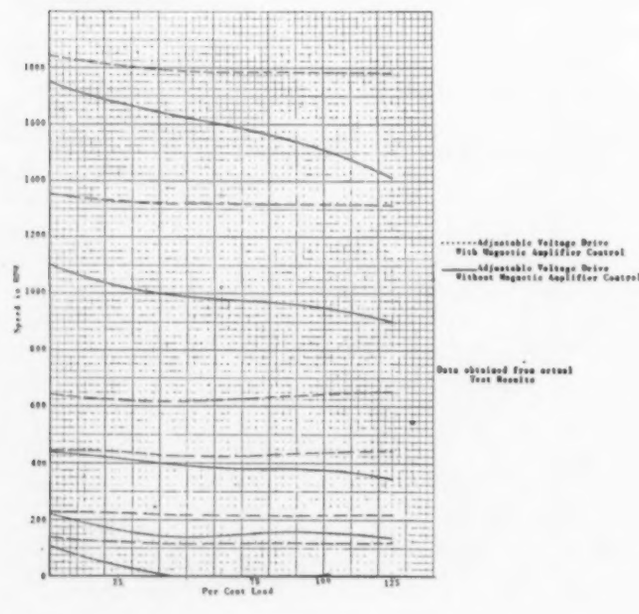


Figure 14 — Control winding was placed across a shunted resistor to measure the voltage drop caused by the current in the resistor.

voltage drop in this internal resistance causes the motor to change widely in speed with a change in load.

Figure 9 shows the typical circuit for this adjustable speed system. The separately excited generator shown here has no load and full load voltage curves as shown in Figure 10. The motor has a constant drop in speed

Figure 15 — Dotted lines show improvement in speed regulation.


Adjustable Voltage Drive With Magnetic Amplifier Control
Adjustable Voltage Drive Without Magnetic Amplifier Control
Data obtained from actual Test Results
Per Cent Load

with load, if the armature voltage does not vary once it is set as shown in Figure 11. When the generator, which drops in voltage with load, is combined with the motor that drops in speed with load, the result is a rather large drop in speed with load as shown on Figure 12. Notice that these particular units, if the motor is running no load at 200 rpm or approximately one-eighth speed, it will completely stall if full load torque is demanded.

If excitation is supplied to the generator through a magnetic amplifier, these objectionable characteristics can be modified to materially improve performance. A circuit like that shown in Figure 13 is used. A voltage divider, placed across the generator output, measures

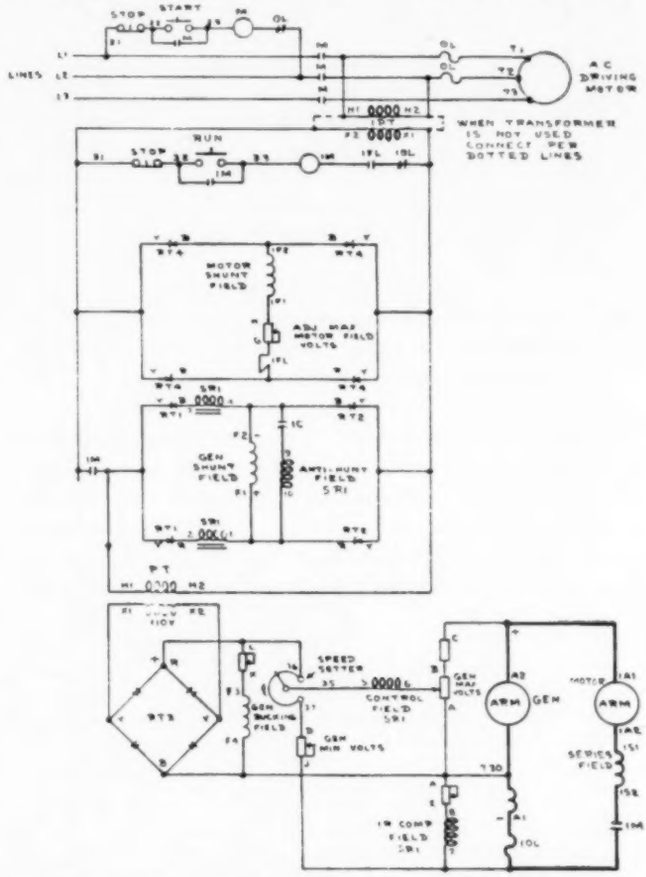


Figure 16 — Elementary diagram for circuit used for speed regulation with magnetic amplifier.

the generator voltage. A reference voltage is obtained from a reference rectifier and selected by the speed setter potentiometer. The output of the magnetic amplifier is controlled by connecting the reference voltage to measured generator voltage in opposition and passing the circulating current, caused by their difference, through one of the windings of the magnetic amplifier. This is a voltage regulating circuit, because if the generator voltage is too high, current diminishes in the magnetic amplifier winding, lowering the generator excitation and thus lowering the generator voltage to the correct value. If the generator voltage is too low, the current increases and the magnetic amplifier raises the generator excitation until the correct value of voltage is reached. This action then overcomes the condition shown earlier on Figure 10, and causes the voltage to hold the set value regardless of the load.

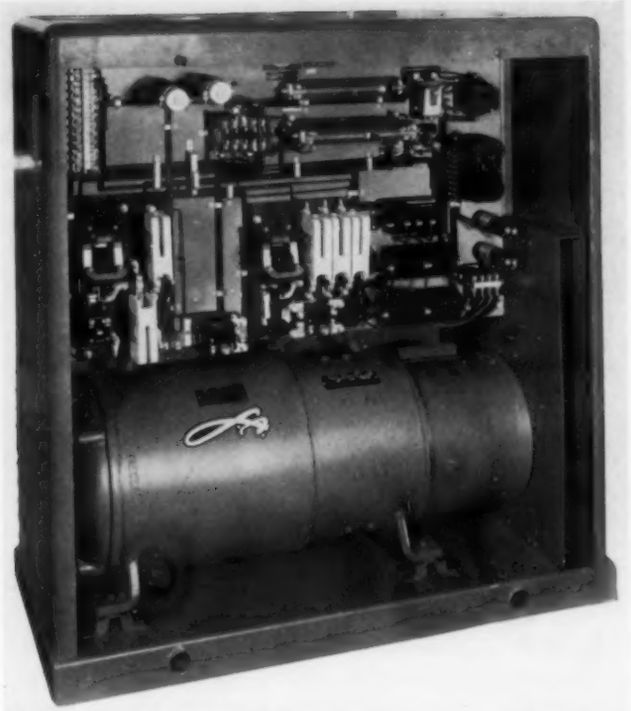


Figure 17 — This model magnetic speed regulator comes in package units to handle drives for 5 to 200 hp.

Maintaining a constant generator voltage is only the first step necessary in reducing the amount of speed change with change in load. The next step has to do with constant drop in motor speed shown on Figure 11. This change is the result of "IR" drop in the motor armature circuit. To correct for this, it is necessary to raise the voltage by a definite amount for a definite

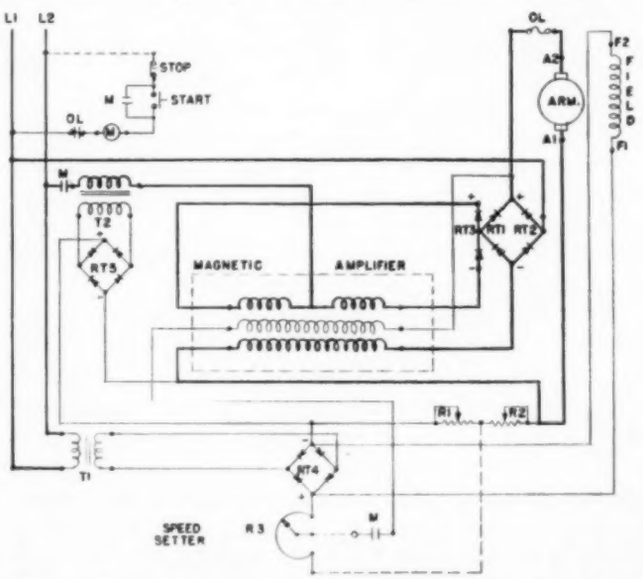


Figure 18 — In small sizes it is possible to use the output of the magnetic amplifier directly as an armature motor supply.

load change. The magnetic amplifier can be caused to achieve this result by making use of a second control winding. Figure 14 shows how this control winding is placed across a shunting resistor in the loop circuit to measure the load by measuring the voltage drop caused by current in this resistor. An increase in current in this

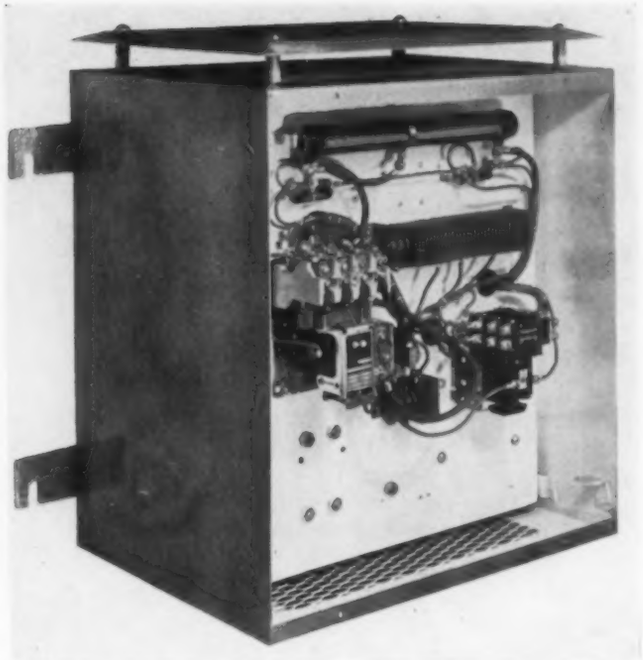


Figure 19 — Complete speed control assembly for small drives are available in package units from ½ to 3 hp.

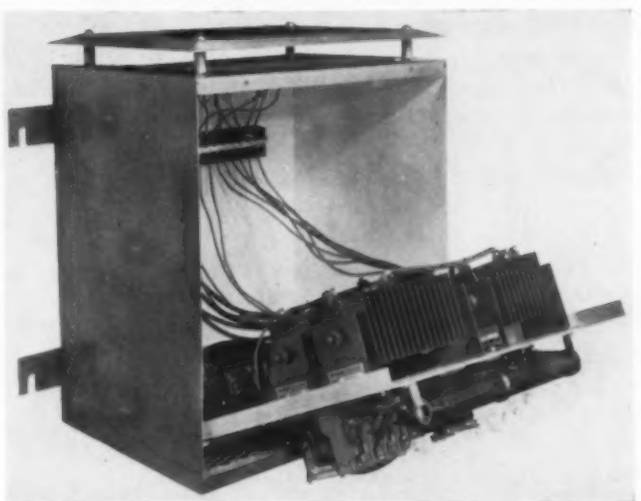
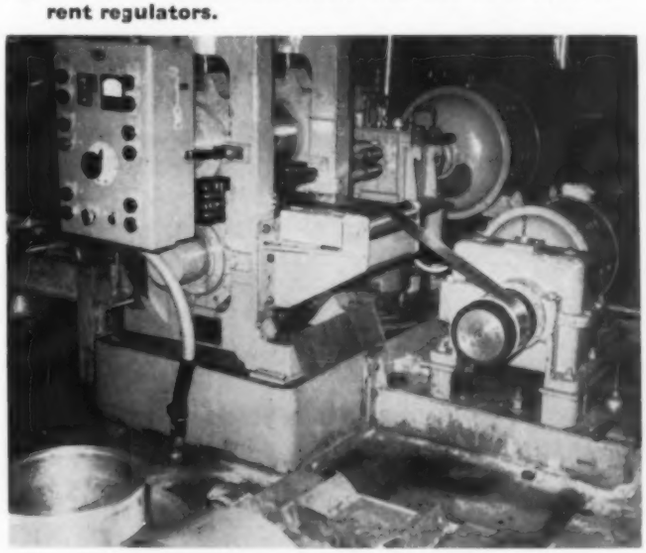


Figure 20 — Photograph shows how simple it is to get at the back of the unit shown in Figure 19.

Figure 21 — Magnetic amplifiers may also be used as current regulators.



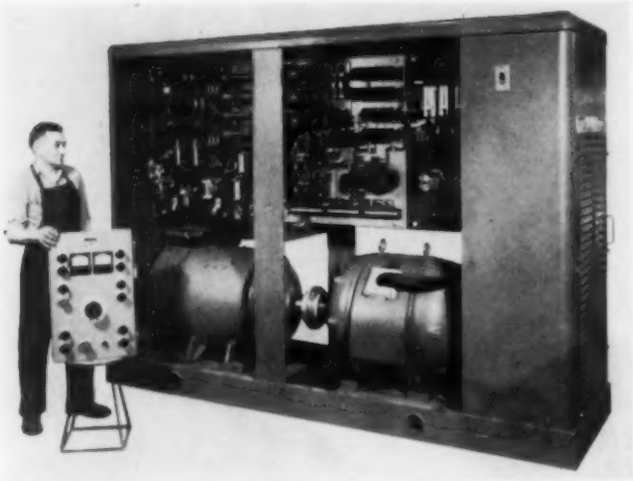


Figure 22 — Power unit of operators control panel of magnetic amplifier current regulator.

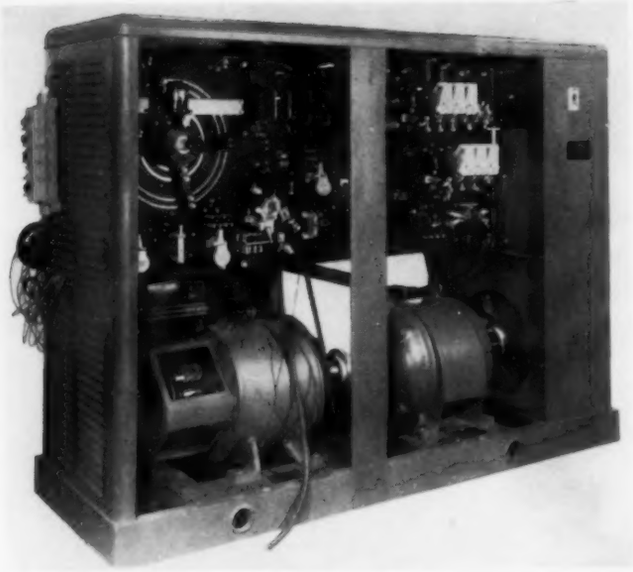


Figure 23 — For high accuracy, two stages of amplification may be required in speed regulator.

winding causes an increase in generator excitation and an increase in generator voltage. By establishing the proper relationship, the voltage can be caused to increase enough to hold the speed almost constant.

How well this is actually accomplished is shown by Figure 15, where the solid line is the speed load curve without magnetic amplifier control, and the dotted line shows the improvement obtained in holding the speed as the load increases when a magnetic amplifier is used. Figure 16 shows the complete circuit. Figure 17 shows the unit which uses this circuit, and which is available as a packaged drive in sizes from 5 to 200 hp.

For a similar drive in smaller sizes, it becomes practical to use the output of the magnetic amplifier directly as a motor armature supply without interposing a generator. The principle used here is much the same. First, a regulated armature voltage is obtained. This voltage is then caused to increase as the load increases to compensate for motor "IR" drop. Figure 18 shows the circuit used to obtain these results. Figures 19 and 20 show a complete assembly of this unit. It is available from ½ to 3-hp as a packaged drive.

It is also possible to use a magnetic amplifier as a current regulator. The signal is obtained from a dropping resistor in the loop circuit. It is compared to a fixed reference. The difference controls the amplifier output which, in turn, controls the output of the second magnetic amplifier. The second magnetic amplifier excites the motor field and operates to strengthen it on an increase in load current in the loop circuit. This type of control is used on wind-up applications in many industries. Figure 21 shows it applied to a mill and reel drive. Figure 22 shows the power unit and operator's control panel.

Magnetic amplifiers also make good speed regulators. Again, for high accuracies, two stages of amplification are required. A typical one is shown on Figure 23. Here a tachometer measures the motor speed in terms of volts. This voltage is compared in the magnetic amplifier which corrects whenever a difference exists. A second stage of amplification gives accuracies of the order of plus or minus ½ per cent.

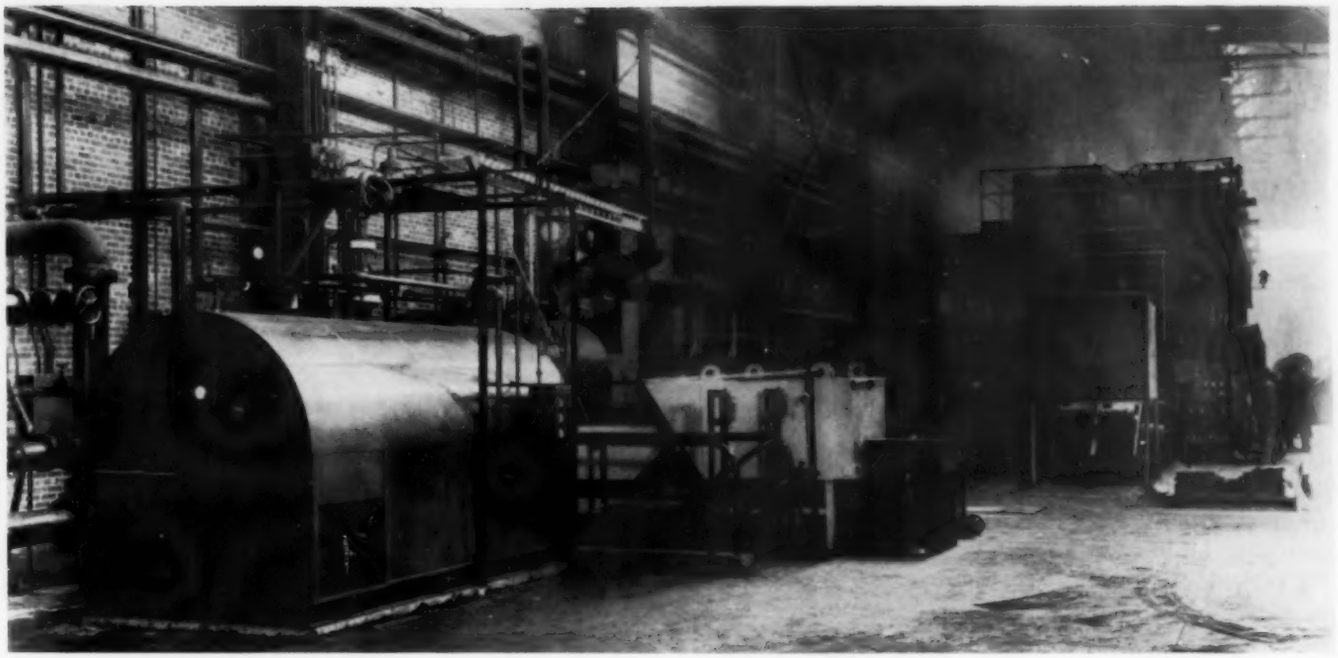
The magnetic amplifier is a panacea for all problems. It is a good device and it will be superseding electronic regulators, rotating regulators and even ordinary exciters in many cases when it can do a better job, and at the same time give more trouble-free operation. There will be others where rotating or electronic regulators continue to be used because they can do the better job. It is the function of the electrical application engineer to be well acquainted with the capabilities of many devices and by bringing together the proper parts, produce a drive and thus a machine that is simple to operate and service, and yet performs in exactly the manner required. The magnetic amplifier is definitely one of the devices to be considered.

There is a demand for copies of the following Yearly Proceedings:

1935 1936 1937
1941 1942 1943
1944 1947

If your copies are not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.



Typical low pressure carbon dioxide system protects oil cellars and mill motors. Storage tank holds four tons of liquid carbon dioxide.

Use of Low Pressure Carbon Dioxide for Fire Control

By H. V. WILLIAMSON, Director of Research, Cardox Corp., Chicago, Ill.

. . . . engineering of fire protection systems depends a great deal on the knowledge and diligence of the fire protection engineer . . . .

▲ TO many it may seem a little strange that there might be extensive use for carbon dioxide in an industry that daily blows off many thousands of tons to the atmosphere. The fact remains that processed carbon dioxide is used in considerable quantities to extinguish fires and prevent explosions.

A study of the case histories of serious fires and explosions will show that a major factor in these disasters is lack of information or simple negligence on the part of the human element involved. This applies not only to personnel directly involved, but also to others responsible for engineering, production and general safety. Hindsight is always easier than foresight, but foresight can be improved by a diligent study of the facts.

The facts relating to the use of low pressure carbon dioxide are pertinent to this problem. The purpose of this paper is therefore to provide general information relating to the characteristics of low pressure carbon dioxide and particularly to its use in extinguishing fires and preventing explosions.

LOW PRESSURE CARBON DIOXIDE

Carbon dioxide is certainly not a cure-all for every fire extinguishing or explosion-prevention application. On the other hand for many important applications it is one of the most efficient and practical agents. Typical applications would involve combustible materials such

as electrical insulation, lubricating and cooling oils, other combustible fluids and combustible gases. The availability of carbon dioxide in bulk quantities in low pressure equipment has extended its use to many applications formerly considered impractical or too costly.

The term "low pressure carbon dioxide" is used to designate bulk carbon dioxide as handled in insulated and refrigerated pressure vessels at the comparatively low pressure of 300 psi. This is opposed to "high pressure carbon dioxide" where the gas is stored in the familiar cylinders at ambient temperatures and a corresponding pressure that may reach 1,800 psi or even higher under some circumstances. Since low pressure containers need only be designed for working pressures of approximately 325 psi ordinary welding techniques can be used and the capacity can be many times larger. Transport tank trucks normally have capacities ranging from 3 to 12 tons while stationary storage tanks have been built with capacities as high as 125 tons.

For the large user of carbon dioxide, there are additional advantages in using low pressure equipment that may not be entirely obvious. At 0 F and 300 psi the density of liquid carbon dioxide is about equal to that of water. Even after allowing some vapor space for expansion and refrigeration coils, the storage tank can be filled to a density of approximately 95 per cent of its water capacity. Because of the fact that liquid carbon dioxide expands as it warms up, the normal high pressure cylinder can only be filled to a density of 68 per cent of its water capacity. Because of this, the total volume of the required container for a given capacity of low pressure carbon dioxide will be considerably less and of course the space occupied by the container will be very much less than the space required for equivalent high pressure containers.

For fire extinguishing applications, low pressure carbon dioxide has the further advantage of having an appreciably greater cooling capacity. Liquid carbon dioxide stored at 0 F will be converted to approximately 47 per cent snow or dry ice when it is discharged to the atmosphere. Carbon dioxide stored at 80 F will produce only about one-half of this quantity of snow when discharged to the atmosphere. When stored above the critical temperature of 87.8 F there will be no liquid phase. This does not mean that there will be no snow formed in the discharge, but the quantity of snow formed continues to decrease as the storage temperature is raised.

With low pressure carbon dioxide storage equipment, it is generally better to have one large unit rather than a number of smaller units serving separate hazards. It has become common practice therefore to use a centralized storage unit with fixed piping running to a number of fire hazards. An automatic valving system is provided to direct the flow of gas to the particular hazard that may require it. The specific amount of gas required for the particular hazard is controlled by means of the discharge rate as determined by the size of the pipe and the nozzles and also by an automatic timing system that opens the discharge valve for a predetermined length of time and then closes it. In a system of this type the storage unit must have at least a minimum capacity capable of protecting the largest hazard. Frequently a capacity sufficient to give double protection to the largest hazard is provided for additional safety. For the average hazard, the storage vessel will thus have more than ample capacity for almost any contingency.

In conjunction with certain types of hazards it is frequently desirable to provide hose reels for manual protection even though the obvious fire area may be protected with a fixed system. Since this hose reel is connected to the main storage tank there is no danger of running out of carbon dioxide at a critical stage during the attack on the fire.

LOCAL HAZARDS

Many of the hazards around a steel mill are of the open or local variety which must be extinguished by direct application of carbon dioxide on the burning material. Such systems are called direct local application systems. The important facts about these systems are: (1) the carbon dioxide discharge must be distributed in such a manner as to completely cover all of the burning material; (2) the rate of discharge and the length of the discharge period must be such that the fire is completely extinguished and cooled below the re-ignition point during the discharge period and, (3) any associated hazard must be simultaneously protected if there is any possibility of the fire extending from the main hazard to the associated hazard.

The quantity of carbon dioxide required to extinguish fires of this nature has been determined as a result of experimental work by various people. These results have been extrapolated to cover equipment similar to the test equipment on a surface area or sometimes on a volume basis. For example a simulated transformer setup was used to determine nozzle location and the minimum discharge rate for transformer fires. The tests were made using a transformer shell 5 ft in diameter and 12 ft high. The shell was filled with hot transformer oil which was continuously pumped in so as to overflow the top and create an intensive fire. The fire was then extinguished by discharging carbon dioxide from various nozzles arrangements. This test was repeated again and again with different discharge rates and nozzle locations in order to establish minimum rates and quantities that would extinguish the fire under all conditions.

Tests of this nature serve very well to establish a basis for determining discharge rate and total quantity of carbon dioxide for other similar hazards. They do not, however, firmly establish the location of the nozzles in order to obtain complete coverage of the hazard. For this reason it is desirable to run a full scale discharge test after the equipment has been installed. If the coverage is not perfect as shown by visual observation, the nozzles can then be re-directed or re-located to obtain the desired results.

In transformer fires a discharge period of about one minute is enough to extinguish the fire and allow time for surface cooling. Fires involving electric motors and generators pose a somewhat different problem because of the ventilating effects of the rotor. Even in enclosed units, the amount of leakage is unknown. The discharge

rate must therefore be based on the amount of air passing through the unit or on the leakage rate from the enclosure. The length of the discharge period must also be extended to maintain the concentration for a longer period of time.

Liquid fuel fires in open tanks such as dip tanks can also be handled with direct application of carbon dioxide. Such systems are generally fairly simple because discharge rates for open tank fires have been accurately determined in a great number of tests. One important consideration is the necessity of protecting an area somewhat larger than the dip tank area in order to extinguish any fires around the outsides of the dip tank in case of leakage or splashing. This extra safety factor is sometimes overlooked.

In all of these cases it will be noted that the emphasis is placed on the rate of discharge. This is important because the discharge rate must be sufficiently high to maintain an extinguishing concentration over all surfaces in spite of normal windage or other local conditions. Since the discharge rate is of prime importance, it therefore follows that the pipe line between the storage tank and the hazard must be of sufficient size to give the necessary maximum discharge rate. There is also a practical limitation regarding the length of the pipe line in order to provide an effective discharge containing dry ice with a minimum delay. Since the pipe will be at room temperature to start, it will tend to vaporize the initial flow of liquid carbon dioxide until it has cooled down to the carbon dioxide temperature.

ENCLOSED HAZARDS

In some cases the hazard will be located in a reasonably tight enclosure or room of such size that it can be flooded with less carbon dioxide than would be required for direct application. This process is called total flooding. The quantity of carbon dioxide required can be calculated very accurately on the basis of the volume of the enclosure. The enclosure itself is depended upon to retain the carbon dioxide atmosphere for a sufficient length of time to make certain that all hot spots have cooled below the re-ignition temperature. If necessary, additional quantities of carbon dioxide can be provided to allow for openings such as windows or doors or these openings can be provided with automatic closing devices to assure prompt closing at the start of the discharge.

Since the entire room is to be flooded it is not necessary to direct the nozzles on the fire hazard itself. It is usually desirable to obtain a turbulent condition so as to develop a uniform concentration from floor to ceiling. Also the nozzles must not be directed towards openings in the enclosure. The discharge rate is not as critical as in direct application, since it usually matters little whether one minute or two minutes would be required to obtain the desired concentration.

In one typical example, the oil cellar for a 45-in. slabbing mill had a volume of 40,000 cu ft. Knowing the volume it was a simple matter to determine from total flooding charts that approximately 3,000 lb of carbon dioxide would be required to obtain a concentration of 45 per cent. In this case a concentration of 45 per cent was sufficient for the type of combustible involved. Some materials may require a higher concentration.

In total flooding systems there is sometimes danger of trapping personnel in the hazard during the discharge. In such cases automatic systems are provided with predischarge alarms designed to warn personnel and to delay the discharge for a sufficient length of time to allow evacuation. Although carbon dioxide is not toxic in the poisonous sense, personnel would lose consciousness when exposed to concentrations higher than about 9 per cent. Death can result if allowed to remain in higher concentrations for more than a few minutes. Normally a person hearing the noise of discharge from the nozzles would still have appreciable time left to escape. If he delayed too long, visibility would be reduced and some exposure to the gas might interfere with his ability to think clearly and take action promptly.

EXPLOSION HAZARDS

The third method of applying carbon dioxide involves its use to purge gas or air from equipment so as to prevent formation of explosive atmospheres. This might be termed purging or inerting. Actual purging implies that the unwanted gas is completely displaced, while inerting implies that the combustible gas or air is merely diluted with sufficient carbon dioxide to make the contained atmosphere inert.

For purging applications it has been found desirable to vaporize the liquid carbon dioxide in order to facilitate the problem of controlling the flow and to prevent the formation of dry ice which might otherwise block the flow or damage equipment because of sudden cooling effects. A steam heated heat exchanger especially designed for the purpose is the most convenient means of vaporizing the liquid carbon dioxide. A direct gas fired vaporizer can also be used, however, it is somewhat more complicated to operate than the steam heated vaporizers. At any rate the liquid is vaporized while still under a pressure of approximately 300 psi. The vapor can then be conducted to the point of application by means of a suitable hose or pipe line. The flow of vapor is controlled by means of a valve in this line. If desired, a simple orifice and pressure gage arrangement can be used to indicate the approximate rate of flow.

Since carbon dioxide is heavier than air and most combustible gases, it is usually desirable to introduce it at a low point in the system. The gas that is being purged out must be removed from a high point remote from the point of application of carbon dioxide. In complicated systems this may require purging of vent gas at a number of different points in order to assure complete displacement.

The end point of the purging application can be easily and accurately determined by analyzing the vent gas for carbon dioxide. The Orsat type analyzer that traps a sample of measured volume and then absorbs out the carbon dioxide with a caustic solution has been found to be very satisfactory for this purpose. This is a basic chemical analyzing instrument giving a reading directly in per cent by volume as a result of the re-

duction in volume of the gas sample. Combustible gas indicators do not necessarily give an accurate reading when carbon dioxide is used for inerting. The results of such an instrument may indicate an explosive atmosphere even though it is positively inert.

The concentration of carbon dioxide necessary to prevent an explosion is a subject that has received considerable attention by the Bureau of Mines. In a great number of tests they have determined accurately the minimum concentration of carbon dioxide required to prevent an explosion for most of the common combustible gases and vapors. Table I gives these results for several of the common gases.

TABLE I

Combustible gas	Per cent of carbon dioxide in air	Per cent of carbon dioxide in gas
Hydrogen	62	91
Carbon monoxide	53	74
Methane	25	78
Ethane	33	88
Propane	30	89
Butane	28	90
Hexane	29	93
Ethylene	41	91

It will be noted that the carbon dioxide concentration is shown for two conditions. One condition involves the assumption that carbon dioxide is mixed with air into which the combustible gas is to be introduced. This is the case when a pipe line contains air that must be displaced with carbon dioxide before introducing the combustible gas. The second situation assumes that the carbon dioxide is mixed with a combustible gas and the mixture is to be displaced with air. This is the case when the pipe line contains combustible gas that must be purged out before the pipe line is opened to the air.

Carbon dioxide has been used for some rather large purging applications in various steel mills. In one case, the entire blast furnace gas system was purged to allow general repairs. Four railroad tank cars were used to provide the required amount of carbon dioxide which was nearly 100 tons. The volume of the gas system was about 400,000 cu ft. A number of steam vaporizers were used so that the initial purging was completed in about 4 hours. Because of the complexity of the system, it was necessary to purge gas from 20 different points. After the repair work was completed, the portions of the system that had been opened to the air were repurged so the system could be put back into service safely.

SUMMARY

As discussed, low pressure carbon dioxide can be an important safety tool in steel mill operation. It provides a practical and convenient means for fire protection and explosion prevention. The effectiveness of its use, however, will depend upon the knowledge of and diligence taken by the personnel planning its use.

The engineering of fire protection systems depends a great deal upon the knowledge and diligence of the fire protection engineer. Although the NFPA is making every attempt to maintain adequate standards covering the use of carbon dioxide, it is recognized that there is no substitute for experience.

Engineers involved in the operation of steel mills can personally do a lot to make certain of adequate fire and explosion safety. It is certainly within their province to be concerned about a number of points.

1. The design of the fire extinguishing application should be handled by experienced fire protection engineers with the help of operating information that can be provided by the steel mill engineers.
2. Make certain that all of the hazard is protected. It will do little good to protect one central part of the hazard without providing means for extinguishing fires in associated hazards that might become involved.
3. Insist upon a fire protection system providing a reasonable safety factor. This can be done by providing more than the bare minimum of required carbon dioxide, by providing hose reels to protect fringe areas where necessary and by providing double shot storage systems in critical cases. An engineer, for example, designing a pressure vessel with steel is required to use a safety factor of at least 4 to 1. If this safety factor is required in a product as carefully controlled as steel, it should not be considered unnecessary when dealing with fire and explosion problems.

AISE SPRING CONFERENCE

APRIL 25, 26, 27, 1955

HOTEL STATLER DETROIT, MICH.

By G. J. CAMPBELL, Assistant Fuel Engineer, Bethlehem Steel Co., Sparrows Point, Md.

Use of HIGH VELOCITY BURNERS for Edge Heating Skelp

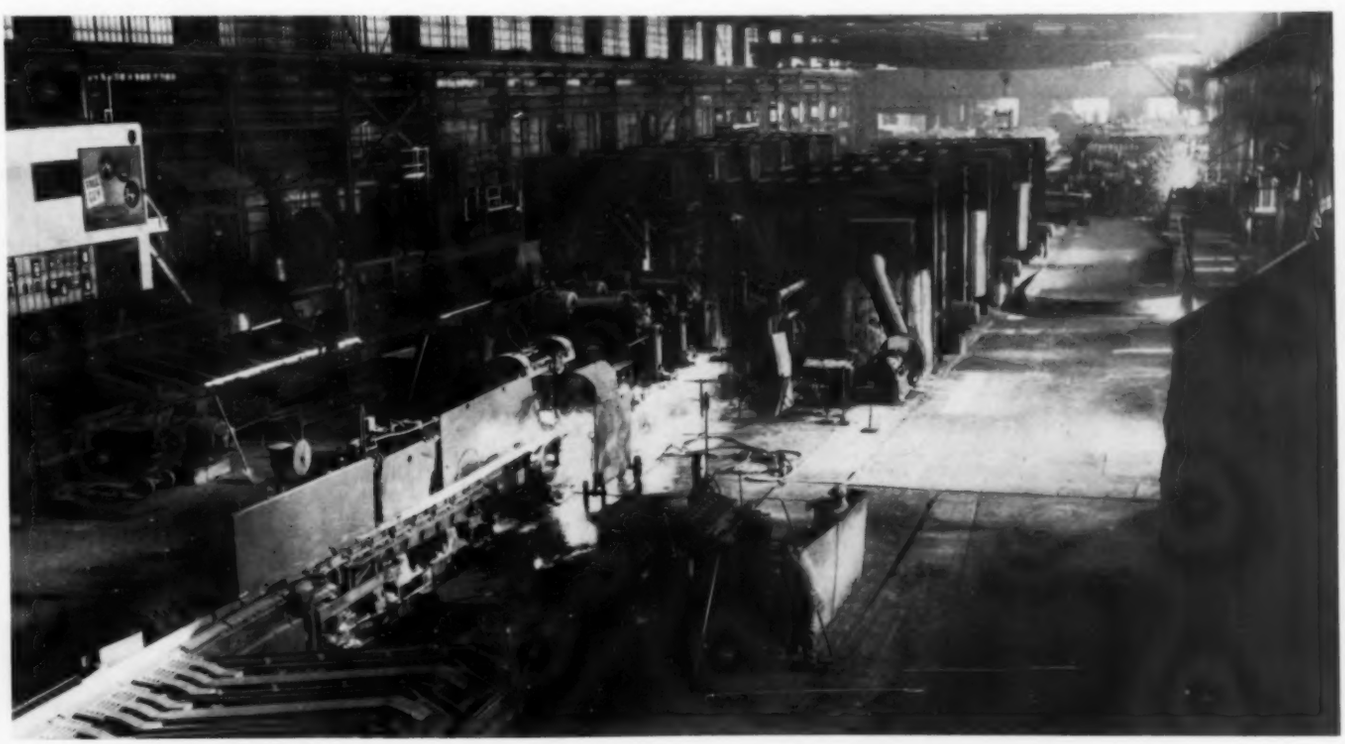
. . . . high velocity burners offer promise in economically increasing furnace production . . . .

▲OVER a period of years the producing capacity of the butt weld mills, at the Sparrows Point Plant, of the Bethlehem Steel Co., has been increased from time to time by the installation of larger and faster motors, heavier and stronger drives, increased "know-how" and general improvement in the efficiency of our operators. During this same period the furnaces have kept pace with the mill by increasing the furnace temperature, higher fuel input and lengthening the furnaces. We have, however, arrived at the end point, as far as our heating potential is concerned. It is impractical to make the furnaces longer; higher fuel input is limited by stacks, recuperators, combustion air, etc. Furnace temperatures are actually a little too high now, as evidenced by our increasing refractory costs: furthermore higher skelp temperatures and longer furnaces will tend to scale the strip body and burn or oxidize the edge, resulting in an inferior weld and unsatisfactory product.

Since the furnaces would be a bottle neck, in the ever increasing production cycle, the next move was up to the fuel engineers.

Realizing the furnace and heating capacity limitations, we had to cast about for a new approach to the heating problem, and that is why we were receptive to the idea of high velocity burners. Theoretically this was the answer to our prayers; practically it had to be proven by an actual installation.

Figure 1 — No. 1 butt weld pipe mill shown on left produces ½ to 1¼-in. pipe and No. 2 mill on right produces 1½ to 4-in. pipe.



In spite of the potential hazards to production, because of delays, poor product, burners not operating properly or possibly not at all, the cost of purchasing burners and equipment plus installation, the operating department was willing to go along with a trial installation.

Needless to say there were "bugs" in the system; the first set of burners were not right, a new set was designed, manufactured and installed; other faults developed which had to be corrected, and all in all the supplier, the operating department, the service departments and the fuel department sweated out six weeks of trial and error before a satisfactory answer was finally found.

Before going into further details of the installation, the butt weld process will be reviewed.

At Sparrows Point, there are two continuous butt weld pipe mills. No. 1 mill is designed for producing pipe ½ to 1¼-in., No. 2 mill for 1½ to 4-in. pipe. Essentially the mills are divided into the following units: skelp welder, loop, furnace, 6-stand forming mill, cut-off saw, descaling and sizing rolls, and cooling rack. Figure 1 shows a complete view of the mill with No. 1 butt weld on the left and No. 2 mill on the right.

Skelp is received in coils; an electric welder is used to join the ends of the coils, making a continuous strip going to the mill. After welding, the coil is run out on the floor in a loop, which provides take-up time for making the next weld. Figure 2 shows a view of furnace, recuperators, loop, welder, etc.

The skelp is then continuously fed through the heating furnace, where, on leaving, it passes through six sets of rolls. No. 1 set of rolls forms the skelp from flat to round, No. 2 set welds the pipe and the remaining four sets reduces the outside diameter of the pipe and finally establishes the finished hot size. Figure 3 is the mill proper, saw, chain conveyor, cooling racks, etc.

The pipe next passes an oscillating synchronized circular saw which cuts it into any desired length from 7 to 50 feet.

By means of a chain conveyor the pipe passes across a hot rack into three sets of descaling and sizing rolls and finally on to a cooling rack.

Table I gives some pertinent data on the furnaces.

TABLE I

	No. 1	No. 2
Furnace length, ft	163	170
Furnace width (inside) in.	27	27
Number of zones	3	3
Number of burners		
No. 1 zone	106	132
No. 2 zone	110	110
No. 3 zone	80	114
Total	296	356
Fuel—530 Btu coke oven gas, cfhr		
No. 1 zone	55,000	90,000
No. 2 zone	55,000	80,000
No. 3 zone	45,000	80,000
Total	155,000	250,000
Combustion air preheat, F	600	600
Furnace temperature, F		
No. 1 zone	2,400	2,500
No. 2 zone	2,750	2,800
No. 3 zone	2,950	3,000
Pipe size, in.	½ to 1¼	1½ to 4
Skelp size — Gage, in.	0.102 to 0.128	0.125 to 0.225
— Width, in.	3 3/16 to 6 5/16	7 3/8 to 15 7/8
Mill speed, fpm	600 to 340	380 to 140

As the skelp passes through the furnace, it is progressively heated from room temperature at the entry end to 2450 F body temperature at the exit end. The edge temperature will be slightly higher, probably 2600 F while the furnace will be at 3000 F.

Welding is accomplished after the skelp leaves the forming rolls, by means of a jet of air (sometimes enriched with oxygen), applied at the seam, which brings the two adjacent edges up to welding temperature before they pass into the welding rolls. Figure 4 shows the skelp leaving the furnace and entering the forming and welding rolls.

Normally, the temperature of the furnace, strip and

Figure 2 — Coil is run out on the floor after welding to provide take-up time.

Figure 3 — Circular saw cuts pipe into lengths from seven up to 50 feet.

Figure 4 — As the skelp leaves the furnace, edge temperature is about 2600 F.

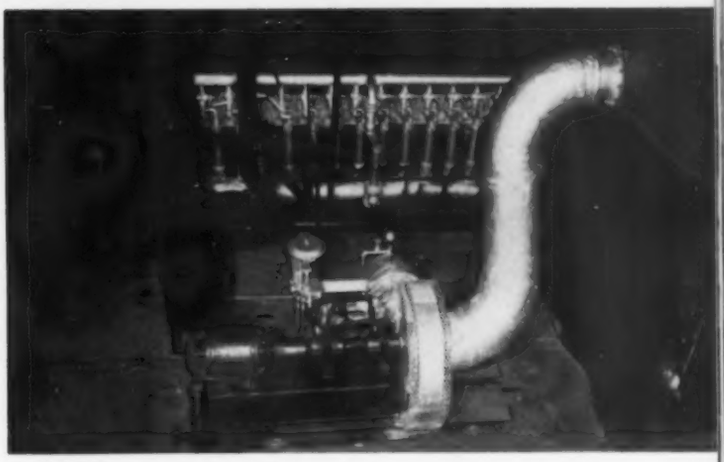


Figure 5 — The installation of high velocity burners increased furnace production.

welding seam must be controlled within very close limits in order to make first quality pipe. As we do not have completely automatic control to compensate for the many variables, such as furnace temperature, skelp body and edge temperature, mill speed, etc., the operator must depend entirely on visual observation of the skelp and he manually controls the mill speed to maintain a suitable welding bead at the seam.

High body temperature will cause buckled or warped walls, while low edge temperature gives poor welds. On the other hand, low body and high edge temperature not only makes a superior product but also permits operating latitude far beyond the span permissible with limited temperature tolerances.

Upon investigation we felt high velocity burners would improve quality and production of the mill by providing the desired temperature of 2350 F for the body and 2600 F or higher for the edge skelp. Figure 5 shows the installation of the high velocity burners.

A trial installation was ordered, early in 1953, and we subsequently placed 13 burners on each side of the discharge end of the furnace with high-velocity burners along with the necessary gas header, preheated-air header, control valves, and high-temperature fan. We also altered our existing recuperator to furnish the required preheated combustion air. Figure 6 is a cross section of the furnace showing the relative positions of the skelp, burners, gas and air piping.

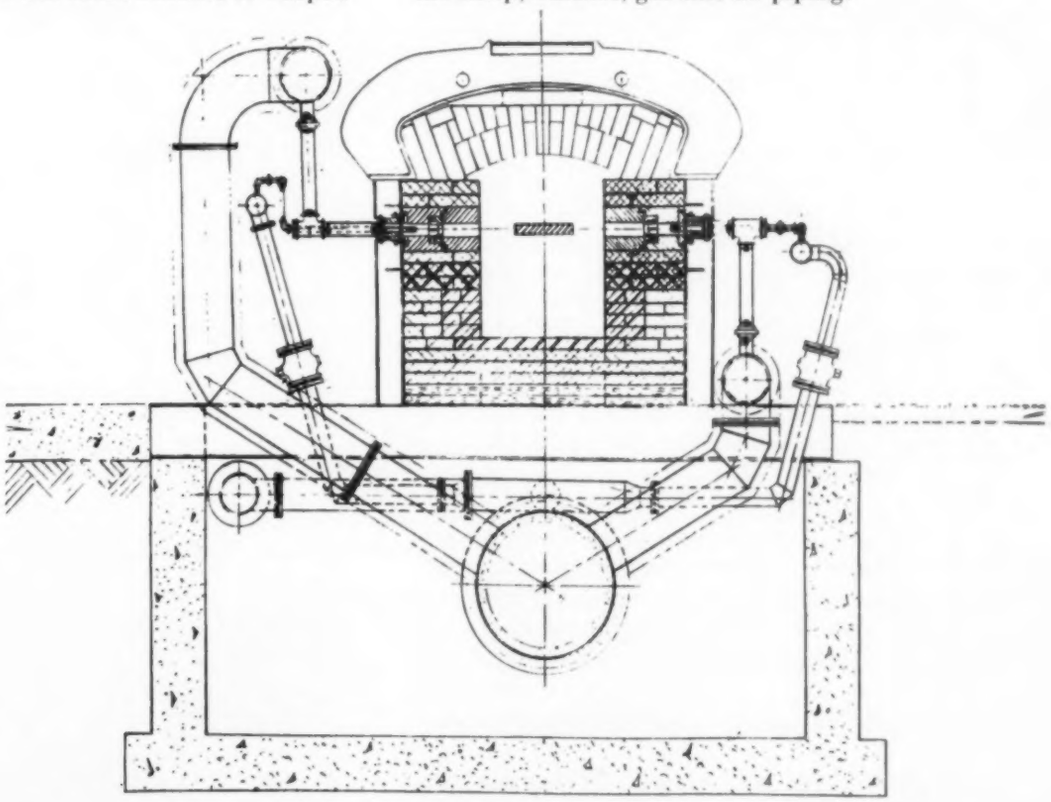


Figure 6 — Cross section of furnace shows positions of skelp, burners, gas and air piping.

Figure 7 shows a cross section of the high-velocity burner assembly. Preheated air is injected into the burner through a back-up block of 2½-in. inside diameter. The gas nozzle, connected to a ¾-in. stainless steel pipe is inserted through the 2½-in. air port and into the back-up block. Gas passes into the air stream through six 3/16-in. diameter ports at right angles to the air stream. Several inches beyond the gas nozzle, the combustible mixture passes a ceramic baffle-type igniter bar. The baffle effect of the igniter bar, which is

centered in the gas and air stream, eddies a small amount of combustible mixture, setting up a primary flame front. Just downstream of this point is a shoulder-type flame-holder which is merely an abrupt increase in diameter. This causes further turbulence at the outer portion of the moving mixture, establishing another

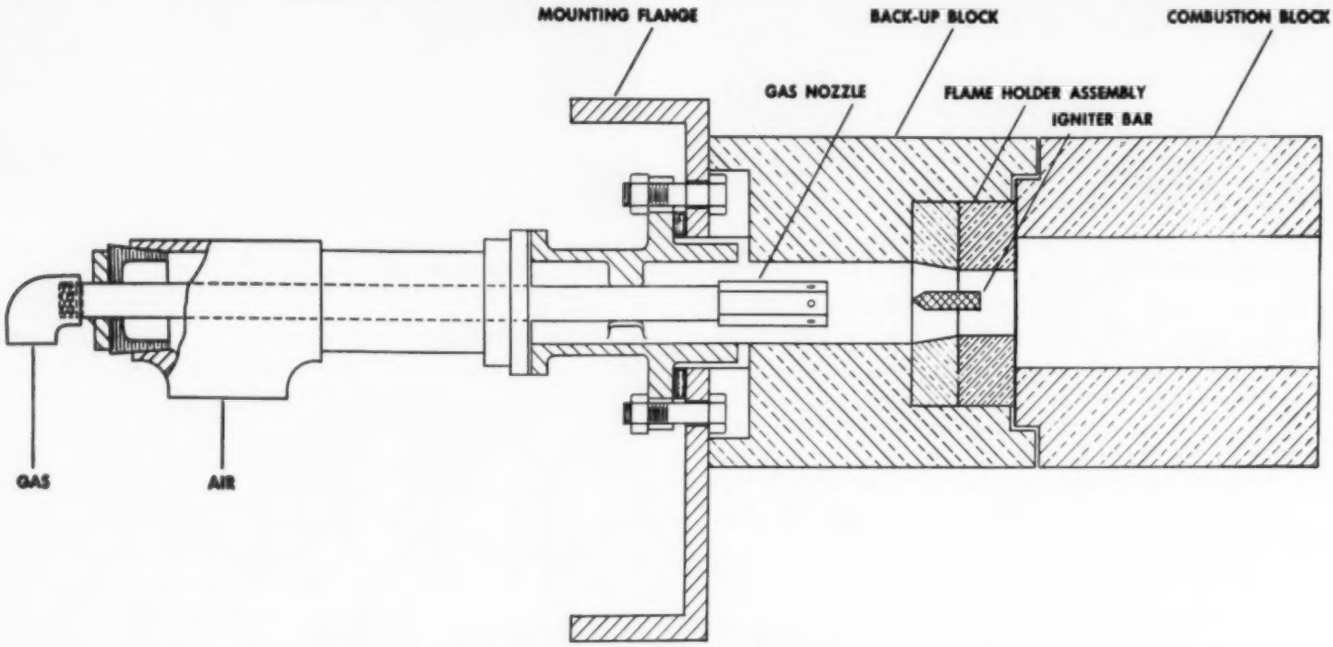


Figure 7 — Cross section shows high velocity burner assembly.

flame front. These two flame fronts, one from the igniter bar and one from the shoulder flame-holder are positioned so that all the unburned mixture must pass through them. This intimate mixture causes the combustion process to take place very rapidly—with a heat release rate of over 5,000,000 Btu per hour per cubic foot of combustion volume. The flame extends only about 6 inches beyond the face of the combustion block.

Since the fuel is being burned nearly entirely within the confined area of the combustion block, which is but 3½-in. in diameter, the next velocity of the gases is very high. This is due to thermal expansion and not to a high inlet mixture pressure. The resulting high-velocity, high-temperature jet-like gas stream impinges directly on the edge of the skelp, raising its temperature rapidly to 2600 F, while the body of the skelp remains fairly constant at 2350 F. Figure 8 gives a view of the burner completely assembled and ready for installation in the furnace. Figure 9 is an exploded view of the burner.

With high-velocity, high-heat-release burners, heat transfer to the skelp edge is principally by convection, with only a small amount from radiation.

In the conventional burner the exit velocity is relatively low so that little convection is realized on the skelp edge. Since the heat release rate in terms of Btu per hour per cubic foot of combustion space is only about one-tenth that of the high-velocity burners, the entire furnace volume is filled with flame and any localized heating of the edge is not possible. These characteristics allow a number of advantages to be listed in favor of the high velocity burners:

1. Because of the jet-release principle, heat can be directed to the edge of the skelp only.
2. Extremely high flame temperatures are possible, and to some extent controlled by using combustion air at the desired preheat.

Figure 8 — Burner is assembled ready for furnace installation.

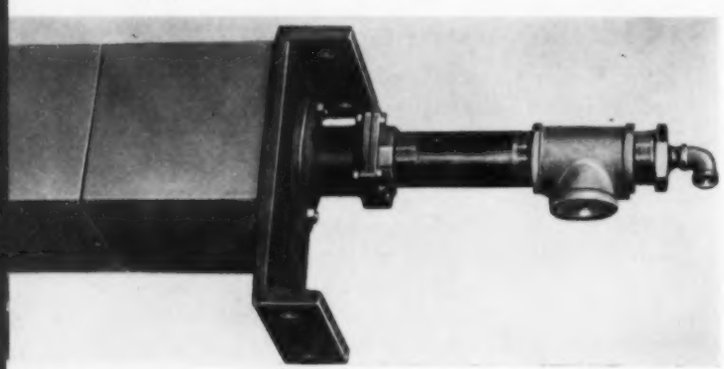
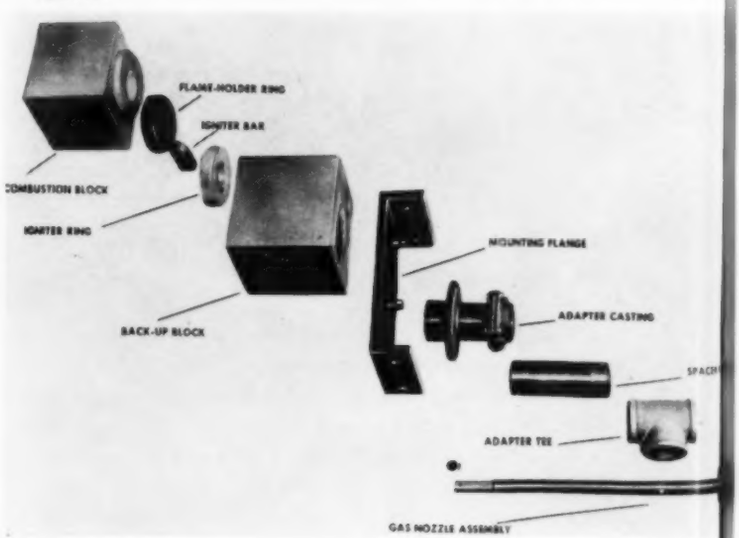


Figure 9 — Exploded view of burner shows the component parts.



3. Skelp edge can be held at temperatures 50 to 400 F higher than body temperature if so desired.
4. Because of the lower body temperature, thin wall pipe can now be successfully made in this mill without high scrap loss.
5. While furnace temperatures are approximately the same as with conventional burners, lower fuel input has reduced recuperator temperatures and increased their life.
6. This lower recuperator temperature also results in a savings in other refractories, burner tiles, and fuel.
7. Lower forming temperatures and increased depth of weld will improve both quality and yield of pipe.
8. Lower forming temperatures permits higher mill speeds, without buckling or stretching, which in turn also increases production.
9. After furnace repairs, or any delays, maximum operating speeds are reached much faster than previously, because maximum furnace temperatures do not have to be attained before maximum production can be accomplished.

Table II shows the operating and designed conditions of the burners.

TABLE II

	Operating conditions	Designed conditions
Btu/hr output	310,000	500,000
Coke oven gas, Btu/cf	530	530
Gas pressure, in.H_2O	6.0	14.0
Air pressure, in.H_2O	5.0	12.0
Air preheat, F	650	800
Velocity, fps	120	200

As can be seen from Table II, the burners are not being used at their designed capacity. This will later be corrected with the installation of a larger combustion air fan.

We also plan on replacing more conventional burners with the high-velocity type on No. 2 furnace. How many will be replaced or how quickly we proceed will be determined through experience.

Plans are also under way to equip one zone of No. 1 furnace with high-velocity burners.

Just prior to the installation of the high-velocity burners, a 13-ft section was added to the entry end of the furnace. However, no burners were installed in this zone, the only benefit sought was to take advantage of some preheat. Following the installation of the high-velocity burners, plus lengthening the furnace, tonnage rates have consistently increased.

Table III gives various tonnage rates.

As can be noted from the tabulation of tonnage rates, the 8-hour and 24-hour tonnage records have increased materially since the installation of the high-velocity burners, but more important, the tons per operating hour are also up, in other words—we are now able to attain and hold a higher operating rate. The net result is a monthly increase in overall tonnage of approximately 8.5 per cent with 5.0 per cent credited to burner change and 3.5 per cent due to the lengthening of the furnace.

TABLE III

Pipe size, in.	1½	2	3	4
8-hr Record — tons				
Conventional burners	251.2	284.2	326.6	364.5
High-velocity burners	271.8	305.5	338.1	374.5
Per cent increase	8.59	7.53	3.51	2.74
24-hr Record — tons				
Conventional burners	738.1	839.0	924.0	1065.1
High-velocity burners	782.2	859.8	987.9	1071.8
Per cent increase	5.84	2.47	6.91	0.63
Tons per operating hour (less roll change turns)				
Conventional burners	26.43	31.73	36.36	38.73
High-velocity burners	28.67	32.60	40.74	41.89
Per cent increase	8.47	4.75	12.05	8.16
Tons per hour (overall)				
Conventional burners	25.45	30.77	35.33	37.50
High-velocity burners	27.20	31.61	36.93	39.98
Per cent increase	6.80	2.73	4.53	6.61
Million Btu per ton				
Conventional burners	4.536	3.927	3.525	3.323
High-velocity burners	4.417	3.885	3.472	3.156
Per cent decrease	2.6	1.1	1.5	5.0

Our No. 1 furnace was also lengthened 13 feet, but without high-velocity burners. The percentage increase in tons per operating hour in this case is about 3.5 per cent.

We are pleased with our progress and while 5 per cent improvement does not seem large, there are a number of important points to remember. We have only changed 26 burners out of a total of 356. Our refractory, fuel, and maintenance costs show a downward trend, even with this small burner change. The furnace will again keep pace with the production improvement cycle. We have a new approach to heating problems, not necessarily limited to the butt weld process.

DISCUSSION

PRESENTED BY

W. K. LOMBARD, Sales Manager, Thermal Research and Engineering Corp., Conshohocken, Pa.

ROBERT BLACK, Field Engineer, Bethlehem Steel Co., Bethlehem, Pa.

FRANK A. BAKER, JR., Chief Engineer, Bethlehem Steel Co., Sparrows Point, Md.

PAUL P. MARINAK, Senior Engineer, Bethlehem Steel Co., Steelton, Pa.

JACK E. WEBER, General Supervisor, Fuels and Instruments, United States Steel Corp., Fairless Hills, Pa.

C. N. CODDING, Plant Engineer, United States Pipe and Foundry Co., Burlington, N. J.

EDWARD E. CALLINAN, Combustion and Refractories Engineer, Alan Wood Steel Co., Conshohocken, Pa.

G. J. CAMPBELL, Assistant Fuel Engineer, Bethlehem Steel Co., Sparrows Point, Md.

W. K. Lombard: When the burner installation discussed by Mr. Campbell was still in the talking stage, which was about two years ago, all we had to offer was a combustion principle which produced a higher than average heat release rate. A proven utilization of that higher heat release rate has now been made. The burners now in use retain the combustion characteristics as originally discussed, but the mechanical design details have been developed to fit this particular type of furnace. This could not have been done without the complete cooperation we received from those individuals at Sparrows Point who were associated with the job.

The results of this installation have brought out an important point: the term "high heat release rate" is only relative. The type of furnace described by Mr. Campbell has been known since its inception to require a very high heat release rate combustion system, one of the highest in the industry, yet, this did not mean that it could still not be increased to even higher rates—and the limit has been by no means reached.

We are confident that further tonnage increases can be had by more burners directed at the skelp edges in the high temperature zones. Also, a great potential exists in the lower temperature zones at the entering end of the furnace. Here, the burners could be mounted to fire above and below the skelp, since the edge heating effect would not be necessary until the final stages. By directing the burners parallel to the skelp surface, but just above or below the edge, the scrubbing action and subsequent high rates of convection heat transfer available from the high velocity products of combustion could be fully realized.

Let's again express our appreciation to the Sparrows Point personnel for their help and guidance in this installation. We also want to thank the Bethlehem Steel Co. for their desire to make known to the rest of the industry the results of this operation. Basic improvements such as these should be made known, a procedure which can only benefit the entire steel industry.

Robert Black: I would like to know how much trouble you have in keeping your burners clean. Would you explain this igniter bar a little bit more thoroughly?

Frank A. Baker, Jr.: I noticed that your picture depicted a flame that apparently focused right at the edge of the strip in the colored design you had up there on the screen. I wonder if that is actually the way that flame looks and also how you maintain it exactly on the edge of the strip, if that is true. Certainly the strip passing through the furnace is not going to be absolutely flat, and this might cause problems with uneven heating on the edges. Would you elucidate on that a little bit?

Paul P. Marinak: The mounting of the burner to the furnace is of particular interest to me in that I had the opportunity to design a burner for bloom heating. The thing that worried me, even in the developing stages, was what is going to happen to the burner and piping as the furnace is heated and begins to expand.

Jack E. Weber: Do you use the same pressure control ahead of these burners as you did in the conventional burners, and is the fuel control constant? Is all of the fuel, the 530 Btu coke oven gas that you mentioned?

C. N. Codding: I would like to know the grade of stainless used in the burner tip.

E. E. Callinan: I would like to inquire as to the composition of the igniter bar; also the combustion block. Also, I would like to have some information concerning the actual furnace pressure at the discharge end of the furnace.

G. J. Campbell: Mr. Black's question was on the keeping burners clean. We do not have too much trouble keeping the burners clean. Our fuel is 530 Btu coke oven gas and there is a small amount of dirt in it. However, they do get dirty and are taken out occasionally and cleaned. I would say, probably about every two weeks, they are inspected every week, but not always changed or cleaned.

The igniter bar is a silicon-carbide bar, which is placed across, what you might call the throat of the burner, and is in there only as an obstruction. It creates turbulence, and the turbulence in turn creates the primary flame front, as I pointed out on a slide. Its action is very similar to the flame retention tip on the inspirating type burner. It serves the same purpose.

Mr. Baker raised a question about the edge-heating of skelp. We have not had any trouble so far with uneven edge temperature. It has been exceptionally good. The edge of the skelp is held within reasonable position tolerences by the mechanical construction of the furnace, plus the supporting water cooled pipes across the furnace at spaced intervals. The direction of flame, of course, is controlled by the combustion chamber block.

As pointed out before, practically all of the combustion takes place in the combustion block, and as a result, exit-gases are at very high velocity and do not tend to leave the pattern of the block in leaving the burner, so that they do apply directly to the edge of the skelp. Remember, it is a high velocity gas leaving there under pressure, and it is not subject to the variations of furnace drafts or pressure.

As far as the color of the flame is concerned it is intended to show flame formation and shortness of combustion of flame—actually I would say that is just my conception of the way the flame looks.

Mr. Marinak, asked about the mounting frame. The mounting frame is fastened on the furnace frame work. The burner block is cemented in place and is held there by the surrounding refractory wall. It has some firebrick cement around it which holds it in place. But it is not completely fastened, that is, if the furnace wall moves, you will get breakage of the burner block and of course misalignment.

To answer Mr. Weber's question of pressure, our coke oven gas pressure comes into the mill anywhere from 10 to 20 psi pressure, and the control on the furnace is a full-floating flow control, with of course the necessary controls to introduce the proper amount of combustion air, so we are not subject to pressure fluctuations, insofar as the fuel is concerned. As pointed out in the paper the gas pressure at the burner is, 6-in. of water pressure, or fairly low. The fuel supply is constant, the quality variation is small. Over a period of 24-hours you might get a change in Btu of 10, say 528 to 538.

Mr. Codding asked about the stainless steel tip. I imagine it is 18-8.

As to the furnace pressure on the discharge end of the furnace, I would say that furnace pressure is somewhere around +0.6 inches of water. In other words, it is very high.

Robert Black: Is that desulphurized gas you are using?

G. J. Campbell: No, it is not?

W. K. Lombard: The first gas nozzles that were installed were an 18-8 stainless steel, actually a later group was 416, a free-machining straight chrome. We are not as satisfied with the 416 as we were with the former.

The burner blocks are a mullite material.

By DONALD R. SCHEU
Belting Engineer
The B. F. Goodrich Co.
Akron, Ohio

Design and Application of CONVEYOR BELTS for the Steel Industry

. . . . conveyors may offer the most economical method of moving certain bulk steel plant materials . . . .

▲ THE frequency with which belt conveyors move materials at lowest cost per ton is stimulating much interest among engineers of all industries. An understanding of the fundamentals of belt design and application is necessary to make the correct choice of belting while assuring low handling costs. Engineers of the iron and steel industries can further benefit from the background of experience available on belts and belt conveyors used at the sources of their raw materials.

Iron ore has been handled on belt conveyors on the Mesabi Range for many years. The belting manufacturers have many years of experience upon which to draw for selection of belts for unloading, storage and recovery systems. Ore from primary crushers, usually minus 6-in. in size, is being handled on the familiar cotton or rayon fabric belts, with second quality rubber compounds. For heavy impact loading conditions, fabrics with nylon transverse yarns are frequently used. Belts used at ore unloading docks are generally of the same construction. When long high tension belts are required for either mining or unloading service, cord or steel cable constructions are used. Stock piling and recovery belts at the steel mills follow the same design.

Particle weight, abrasiveness, and the fractured edges must be considered in the selection of belts for taconite, Swedish ore, and similar heavy, hard materials. First quality covers are necessary for large size material, while second quality is adequate for minus 2 inch and smaller sizes. The carcasses must be chosen with respect to the lump sizes. Nodules, pellets and

A beltroad can be put almost anyplace. This drawing illustrates how suggested beltroad could make 90 degree changes in direction as it follows the Cuyahoga River up the valley. Transfer points permit one belt to unload to another, thus allowing conveyor systems to make right-angle changes in direction. Beltroads are noiseless, smokeless, economical to operate.

briquettes of beneficiated taconite are extremely abrasive, and first quality rubber compounds are mandatory.

Coal handling belts are designed to fit their environments. The belts used for underground coal mining are often subjected to accidental damage. Where the damage rate is high, belts should have lighter carcasses and thinner covers than belts handling the same coal above ground. Belts conveying coal into power plants generally have heavier carcasses and thicker covers, demanded by this kind of continuous long term service. Steel plant coal belts fall between these two extremes, depending on the type of service. Second quality cover materials suffice for coal handling service. Both fabric and cord carcasses are used.

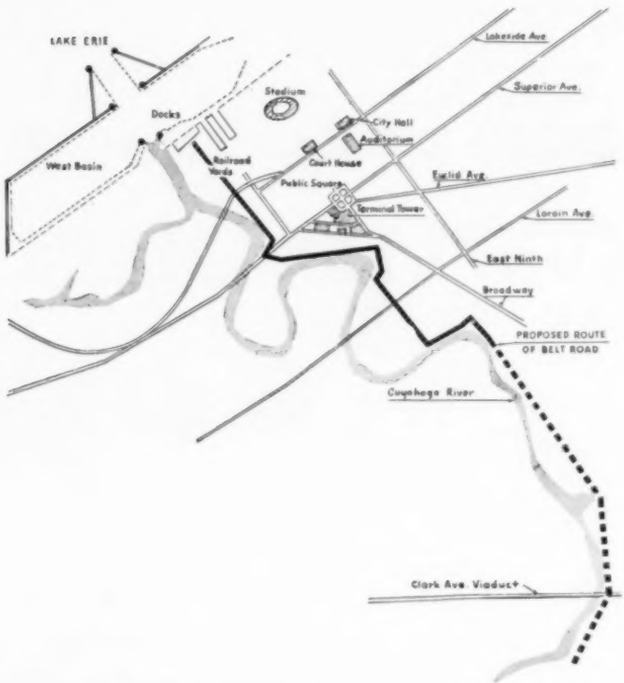
The varying nature of the texture of limestone from different sources requires that a close examination of it be made before belt covers can be selected. Michigan limestone is extremely hard and abrasive, demanding first quality compounds. Some Pennsylvania limestone is softer, and less abrasive and can be handled on second quality covers. The belt carcass choice should be based primarily on the size of the stone handled.

Coke wharf belts should be made of first quality compounds, because of the highly abrasive characteristics. When the coke is hot and contains lumps which are still red hot at the center, hot material cover compounds on cord belts are used. Even so, there is still a belt hazard if lumps break and deposit hot centers on the rubber cover. One steel producer keeps in readiness a complete 5200-ft replacement belt on a reel mounted under the conveyor.

Cold sinter can be handled on second quality covers and fabric carcasses. Hot sinter is best handled on hot material belts, but at a reduced belt life because heat resistance and high abrasion resistance cannot yet be produced in the same belt compound. Crushed slag presents practically the same problems as sinter.

Clean, cold molding sand, tempered sand, and core sand as used in foundries can generally be handled on third quality belt covers. Hot material cover compounds will handle the same sands when hot. When plows are used to unload sand from a flat belt, second quality rubber is required to withstand the abrasion induced by the plows.

Foundry belts operating under hot shakeout screens should be considered expendible. Gates and risers frequently fall on the belt surface, and either burn through or tear through the belt. When the metal protrudes through the belt, it can catch on the idlers, resulting in a ripped belt. Rip-stops in the form of transverse wires built into the belt will prevent ripping the full



One possible route for the four and one-half mile Cleveland beltroad. Where necessary for the conveyor to cross railroad tracks or streets, the beltroad would be elevated to provide necessary clearance for street or railroad traffic. The broken line indicates the area at which the beltroad enters and passes through steel company properties.

length of belt. Auxiliary asbestos or glass fabric plies are sometimes used to prevent the hot metal from burning through the belt. In some foundries the heat is great enough to cause flaming, and the fire is extinguished by submerging the belt in water as it passes under one of the pulleys.

Belts used for conveying metal punchings, stampings, turnings and chips, are invariably subjected to oil. Oil resistant belt covers cost more than the others, but are worth the price.

The suggested application of belt conveyors for conveying iron ore and limestone up the Cuyahoga River

Valley at Cleveland has aroused much interest. The present method is to haul the vast tonnage of material by lake ship to the riverside docks of the steel companies. Passage up and down the river is tortuous and slow.

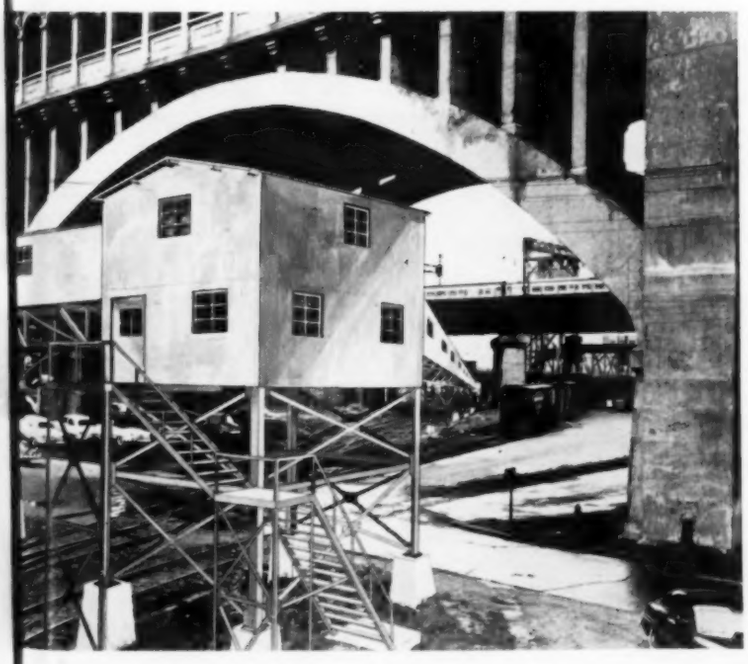
Shipping capacity is reduced by the lost time for the ships making the river trip. A beltroad designed in accordance with standard engineering practice, and stretching four and one-half miles up the Cuyahoga Valley could accept iron ore and limestone directly from ships docking at new lakefront facilities, or from stock piling facilities at the same location. Spur lines could carry the materials to the stockpiles of the individual steel plants. The beltroad could also be extended to the upper valley beyond the navigable stream to furnish the raw materials for expansion of the steel industry.

These examples illustrate only a few of the applications which may be encountered in the iron and steel industry. There is nearly an infinite number possible. Any industry which handles large volumes of bulk materials can benefit from the equipment simplicity and low operating costs of belt conveyors. When a continuous flow of bulk materials is advantageous or necessary, belt conveyors fulfill the requirements.

Let us look at some of the obvious advantages. The mechanical parts of a belt conveyor are simple in design and easily operated and maintained. The power requirement is substantially less than for batch conveying methods. There is less breakage of friable materials. Minimum labor is required for continuous capacity operation. Where floor space is limited, the conveyors can be placed overhead, or in a low roofed tunnel under the floor. Where noise is objectionable, materials can be moved quietly with a belt. Movement of materials can be made over rugged terrain where circuitous roadways or trackage would otherwise be needed.

Run-of-mine coal is loaded to full belt volumetric capacity. Correct idler spacing and belt carcass combine to minimize spillage.

Belt conveyors can be erected and operated without disturbing existing structures. No other means of bulk transportation is as adaptable.



In spite of the recognized advantages, and the knowledge of the mechanical parts, most engineers are not acquainted with the whys and wherefores surrounding the belting. One purpose of this paper is to discuss the general engineering factors involved in the design and application of rubber conveyor belts.

Basically, this type of conveyor consists of a belt operating over two pulleys, and on which can be placed materials for the purpose of movement from one location to another in a horizontal, inclined or declined direction.

The weight of the belt and its load would normally cause the belt to sag between the pulleys, so supporting rolls or idlers are placed at intervals under the belt. The supporting idlers are generally made of three separate rolls with the center roll horizontal and the two end rolls inclined to cause the belt to form a trough. Troughing permits a greater cross sectional area for the load. In order to provide sufficient driving pressure between the belt and the drive pulley, either manually adjusted or gravity weighted take-ups are used. The belt is sometimes wrapped further around the driving

This steel cord belt lifts 1000 tons of Minnesota iron ore per hour higher than a 30-story building. It is 3280 ft long and operates with a tension of 30,000 lb at the drive pulley.

Iron ore is moved quickly from the ship's hold to a distant stockpile at a steel mill. Well designed conveyors and belt loading equipment assure continuous trouble-free ore movement.

pulley by adding a snub pulley or even laced around two driving pulleys to increase the area of contact.

The work a belt does results in stresses being developed within it. These stresses appear as longitudinal tension induced by the drive pulley, bending stresses when the belt passes around the pulleys, flexing stresses when the belt passes over the idlers, and indeterminate stresses induced by impact of the load on the belt surface. Provision for withstanding these stresses is made in the design of the reinforcing members within the belt. Other factors enter into belt design, among which is the selection of rubber or rubberlike materials to bind together the reinforcement materials and to protect the reinforcement from the abrasive, cutting, gouging, heat and other deteriorating effects of the conveyed material.

From this, it can be seen that there are two primary design elements. The first lies in the belt reinforcement, and the second, in the rubber or rubberlike materials to be incorporated in the belt. In the design of a conveyor belt, the compound of rubber or rubberlike materials are not considered to contribute toward the strength requirements. Belt selection is then a matter of choice of carcass construction plus a choice of cover and inter-ply compounds.

Before a carcass construction choice can be made, it is necessary to establish a certain number of details regarding the conveyor itself. The profile of the conveyor must be known in order to establish the length of load travel and the change in elevation of the load, the loading rate must be established, and the belt width established from capacity and speed tables. Three horsepower elements can next be calculated and totalled. Using predetermined frictional coefficients it is possible to calculate separately the horsepower required to run the empty conveyor, and the horsepower to move the load horizontally. The horsepower of elevating or lowering the load is calculated from the usual horsepower formula. From the algebraic sum of these calculated horsepower values and the belt speed selected, the total tension induced in the belt by the drive pulley can be determined, and from that, plus the initial tension for driving, the belt operating tension requirement on a pounds per inch belt width basis can be calculated. This calculated requirement for tensile strength serves as an index for the selection of the carcass or reinforcement.

Carcass selection can be confusing to persons not dealing constantly with belts. The three general carcass constructions are woven textile fabrics, textile cords, and steel cords. Woven textile fabrics are most commonly recognized in the commercial cotton ducks, designated as 28-oz, 32-oz, 36-oz, 42-oz, and 48 oz. These are all-cotton with both the longitudinal yarns and the transverse yarns being of cotton fibers. There are also several specially designed all-cotton belt fabrics being used by various belt manufacturers. Recently, rayon fabrics have entered the conveyor belt picture and are frequently being used to expand the variety of fabric belts. Rayon belt fabrics have greater strength than cotton for a given bulk and simultaneously produce a finished belt of greater flexibility. The present rayon fabrics, when used by belting engineers, are not direct replacements for cotton fabrics. They are used where there is a definite advantage to be gained, rather than in a manner of substitution. As yet, there is no industry standardization in the designation of rayon belt fabrics.

In addition to the all-cotton and all-rayon fabrics, special fabrics are available. These use longitudinal or

warp yarns of cotton or rayon, but with transverse yarns of nylon or kindred textiles. Nylon transverse yarns, for example, have proved very valuable in imparting high transverse strength, resiliency and increased lateral flexibility. This is important in belts which are subjected to external forces which would normally cause lengthwise splitting in the carcass. Also, nylon transverse yarns frequently permit full use of the longitudinal strengths in belts which must be made endless with mechanical fasteners. This happens with nylon because of better distribution of the stresses developed around the fasteners.

Cord belts are designed for use on long length conveyors, where very high longitudinal tensile strength is needed without a corresponding increase in transverse strength. Actually, we could build a belt with a sufficient number of fabric plies to meet the longitudinal tension requirements, but it would have built-in cross-wise strength it would never need. The cords are arranged in plies, with all the cords parallel and each cord completely surrounded by rubber. Such plies are designed solely for longitudinal strength, and two or more plies of fabric are always used in combination with the cord plies to impart the required transverse strength to the belt carcass. The cords may be either of cotton or rayon and appear very similar to the familiar tire cords. Besides providing highest tension resistance with low weight of textile material, cords have excellent impact resistance because they are floated in rubber. The cord belt carcass is more flexible than a fabric belt of the same longitudinal strength. It passes more easily around pulleys, and conforms better with the troughing idlers.

For belts which must operate at extremely high tensions, such as the long length, high lift belts used for open pit mining, textile fabric or cord belts would be exceedingly thick and stiff. They would not conform to the troughing idlers and they would rupture in the outer plies in going around the pulleys. In order to provide adequate longitudinal tensile strength in belts for such services, a single ply of steel cable is used. Belts using steel cables can be designed to operate at tensions as high as 3000 lb per inch of belt width. In belts of this type, special fabrics with high transverse strength are employed to give the belts their required transverse strength.

With either vulcanized or mechanically fastened splices, there may be an entire series of belt carcasses consisting of a certain number of plies of each of the various fabrics and cords, any one of which will meet the tension requirement. An ultimate choice must be made from the series by giving consideration to required functions other than longitudinal strength.

The belt carcass must have sufficient transverse flexibility so that all three of the carrying idler rolls will be contacted by the empty belt. If this is not true, the belt may tend to wander from side to side as it runs. Another requirement is that the belt carcass be stiff enough transversely to remain in the troughed shape between idlers when loaded, thus properly supporting the load and minimizing spillage. Large size material fed to the belt through long chutes will strike heavily on the belt, necessitating high transverse strength and resiliency in the carcass. Belts to be installed on existing conveyors must be selected with consideration for the maximum number of plies which will properly flex around the pulleys. Numerous other circumstances may be encountered on specific conveyors which can affect the carcass selection.

If, after all the various carcass requirements are met, there is more than one suitable construction, the least costly is the natural choice. Selection of rubber or rubberlike compounds for the belt covers is the next step. The rubber compound grades or qualities for most frequently met service conditions fall into one of three common types. For simplicity they are designated here as first, second and third quality, but it must be remembered that the so-called second and third qualities may be superior to the first on certain specific applications.

The compound for the most severe conditions usually is slightly softer and has greater resiliency than the other two. It is expressly designed to combine the highest abrasion resistance, best tear strength, best resistance to gouging and the highest tensile strength possible to obtain in a single conveyor belt compound. These qualities make it suitable for use where the load consists of large highly abrasive lumps which are placed on the belt with heavy impact. Limestone from a primary crusher is typical of the material handled.

This second quality meets the requirements of severe service conditions where the load characteristics do not demand all of the features of the first quality. It is the most widely used. Belts for handling crushed iron ore, run-of-mine coal, gravel, and the smaller sizes of abrasive materials are made with second quality rubber compounds.

The third quality is designed to meet the demands

Razor-sharp edges of sheet metal scrap cut into belt covers. First quality rubber is required. When oils are present, oil resistant belts must be used.

for fairly low price belting for ordinary service. Typical applications of this grade are in small sand and gravel operations, for package conveyors, portable coal conveyors and in foundries for cold core and molding sand.

In order to provide protection against the top cover being pounded or gouged loose from the carcass, a ply of open weave fabric or of spaced transverse cords in rubber can be placed between the top cover and carcass. Such a ply distributes impact stresses and interrupts tearing stresses before they reach the carcass. The value of this feature has been established and nearly all conveyor belts handling lump material have such breaker plies included.

It is the aim of conveyor belt design engineers to make the life of the carcass and the covers equal for obvious reasons of economy. The choice of grade in the belt covers and of cover thickness must be based heavily on previous experience. A short belt needs thicker top cover than a long belt because any given section is presented to the abrasion at the loading point more frequently. Inclined loading areas cause more cover wear than horizontal areas, because the load does not settle on the belt quickly and must be accelerated in the direction of the incline. If the loading chute impinges the load at right angles to the belt or even in a direction opposing that of the belt, excessive cover wear can result.

The inherent abrasiveness and the particle size of the load have considerable bearing on both the top and bottom cover thickness requirements. On conveyors where belt replacements are made frequently because of accidental damage, thinner covers are sometimes advisable, in order to not discard valuable rubber which has not delivered its normal available service.

From the above, it can be seen that the steps in belt selection follow a process of elimination, in the following order:

First—determine the longitudinal stress requirement.

Second—select carcasses capable of handling the longitudinal stress.

Third—choose carcasses from the second step to meet the transverse strength requirements.

Fourth—check for troughability of the carcass.

Fifth—check for load supporting characteristics.

Sixth—select quality of covers.

Seventh—choose cover thickness to suit load material characteristics.

Eighth—select lowest cost belt, if more than one meets all the above conditions.

A word of caution is advisable here with regard to setting up detailed purchasing specifications for conveyor belting. Closely defined physical specifications on the reinforcement, tensile strength and hardness of the rubber compounds, and on the pull required to separate the plies may result in the spelled-out features being supplied, but at the risk of introducing detrimental effects on the resistance to abrasion, cutting, tear, aging, mildew, and other such environmental hazards. These elements can be established only by careful observation of field performance, and not by laboratory tests. Therefore, it is advisable to rely on the recommendations and experience of reputable belting manufacturers.

Portable belt conveyors can be spotted where there is work to be done. Roughened belt surfaces help convey slippery materials on steep inclines.

The major belting manufacturers have published belting handbooks which have been quite widely distributed. Reference to these books will assist materially in the selection of belt carcasses and covers for ordinary applications. However, if any peculiar and troublesome problems exist, these same companies make available competent belt engineering service either by mail or through field representatives.

There are many special service conditions which require specific types of belts which differ from the usual and ordinary designs. For example, when material temperatures are above 140 F, hot material cover compounds and occasionally special carcasses are required to withstand the temperatures. When oils are present, oil-resistant compounds must be used to minimize swelling and softening. For service where acids exist, rubber compounds having a high content of natural crude rubber are generally used, along with cord type carcasses. At high altitudes, belts which are not covered for protection from the sun must be made of special sun-light resistant materials.

New materials for both the reinforcements and the covers are in process of development. New and extensive knowledge and experience is available for the engineering background of conveyor belting. In recognition of these facts, the major belting manufacturers have established engineering groups whose services are availabe to customers and potential customers for assistance in selection, installation, care and maintenance of conveyor and elevator belting. These services are available by contacts arranged through the local sales representatives, and provide excellent assurance that the belt you purchase will have the proper carcass and covers to provide maximum trouble-free belt service at minimum cost.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, November 29, 1954 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Automation Applications of the D-C Motor," by J. L. Van Nort, Manager, Application Engineers Dept., Reliance Electric and Engineering Co., Cleveland, Ohio.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, November 9, 1954 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Heat Balance Studies of an Integrated Steel Plant," by L. I. Dickinson, Assistant Fuel Engineer, Bethlehem Steel Co., Lackawanna, N. Y.

Hotel Sheraton, 715 Delaware Avenue, Buffalo, N. Y.

CHICAGO SECTION

Tuesday, November 2, 1954 — Dinner 6:15 P.M., Meeting 7:45 P.M.

"The Personal Equation," by C. G. Arps, Director of the Speakers' Bureau, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

Phil Smidt's Restaurant, 1205 N. Calumet Avenue, Hammond, Ind.

CLEVELAND SECTION

Data Not Available.

DETROIT SECTION

Tuesday, November 16, 1954 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Atomic Energy and Its Place in Industry," by George Granger Brown, Dean, College of Engineering, University of Michigan, Ann Arbor, Mich.

Main Ballroom, Dearborn Inn, Oakwood Boulevard, Dearborn, Mich.

PHILADELPHIA SECTION

Saturday, November 6, 1954 — Dinner 6:00 P.M., Meeting 7:00 P.M.

"Maintenance Welding of Heavy Sections," by R. E. Metius, Welding Engineer, Mechanical Dept., Bethlehem Steel Co., Sparrows Point, Md.

"Shop Fabrication, Welded Steel Water Mains," by H. C. Von Blohn, Welding Engineer, Fabricated Steel Construction, Bethlehem Steel Co., Steelton, Pa.

"Electro-Static Cleaning of Open Hearth Waste Gases," by R. C. Laney, General Supervisor, Power and Fuel, Engineering Dept., United States Steel Corp., Central Operations, Fairless Hills, Pa.

Engineers' Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Monday, November 8, 1954 — Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Pittsburgh Steel Co.'s New Hot and Cold Strip Mills at Allenport, Pa.," by H. A. Long, Chief Engineer, and J. C. Peth, Chief Electrical Engineer, Pittsburgh Steel Co., Allenport, Pa.

Alumni Room, University Club, University Place, Pittsburgh, Pa.

ST. LOUIS SECTION

Data Not Available.

WESTERN SECTION

Data Not Available.

YOUNGSTOWN SECTION

Monday, November 22, 1954 — Dinner 7:00 P.M., Meeting 8:00 P.M.

"Quality In Steel."
Panel Discussion.

Mahoning Country Club, Girard, Ohio.

A. J. Krombholz Wins AISE Papers Award

▲ PRIZE winning AISE Kelly awards for the best papers in 1953 were given at the banquet held during the Annual Convention of the AISE, in Cleveland, Ohio on September 28, 29, 30 and October 1. First prize went to A. J. Krombholz, director of research, special projects, Weirton Steel Co., Weirton, W. Va., for his paper on "Recovery of Tin From Scrap Tinplate." This plant has been one of the pioneers in recovering tin and scrap steel from cuttings, and a great deal of interest has been shown by the industry on this subject as indicated by the many calls on the AISE for copies of this paper. The paper was originally published in the March 1953 Iron and Steel Engineer.

Second prize went to a joint paper by F. H. Bremmer and F. J. Zehnder on "Continuous Heat Treatment Process Produces High Strength Oil Well Casing." This paper was published in the January 1953 Iron and Steel Engineer. Mr. Bremmer is chief combustion engineer, Spang-Chalfant Div., The National Supply Co., Ambridge, Pa. Mr. Zehnder, at the time of writing the paper, was project engineer of the Spang-Chalfant Div. of The National Supply Co. He is now with the McKay Chain Co., York, Pa. Last year's AISE prize winning first place award also went to a Spang-Chalfant Div. employee, J. L. Holmquist. The Bremmer-Zehnder paper described an economical production method used by their plant for heat treating high strength casing pipe.

Third place went to A. E. Cichelli, lubrication engineer of Bethlehem Steel Co., Bethlehem, Pa., for his paper on "Considerations in the Design of Plain Bearings." This paper is a fundamental paper giving the theoretical background behind bearing design and describes the fundamentals which will help the designer to evaluate and compare different bearing designs.

The committee had a very difficult time in making the selections because of the many outstanding papers published in the Iron and Steel Engineer throughout the year 1953.

Others papers in the running and which received honorable mention included one by J. E. Anderson and J. B. Whitlock on "A Maintenance Material Program," published in the September 1953 issue, a paper by Griffin L. Isaacs entitled "Automatic Control for Regenerative Soaking Pits" published in the February 1953 Iron and Steel Engineer, and two symposiums, one a "Symposium On Open Hearth Availability," in which Edward E. Callinan, W. H. Shure and H. C. Paxson were authors, and another entitled "Water Symposium," in which C. S. Cassels, N. H. Jensen, B. P. Martinez and F. C. Schoen were authors. The "Water Symposium" was published in the March 1953 Iron and Steel Engineer.

The Kelly award carries prizes of $300, $200 and $100 for first, second and third place respectively. The award was established September 28, 1943 to honor John F. Kelly, managing director of the AISE from 1917 to 1934, and to perpetuate the memory of his achievements in the advancement of the Association.

The award is made each year by the board of directors of the AISE upon the recommendations of the editorial and executive committees of the Association.

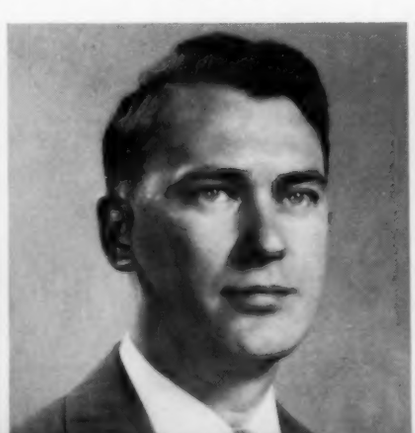
Rules of the award:

1. The award shall be given annually to the author of the paper, adjudged of greatest value in the advancement of engineering or operating practice in the iron and steel industry.
2. The entries for each judging shall be the papers published in the Iron and Steel Engineer during each calendar year, although some may have been presented at meetings in the previous year. Voluntary contributions of papers not presented at meetings but published by the AISE are also included in the judging.
3. To be eligible for the award, the author must be directly employed in the iron and steel producing industry. The author need not be a member of the Association of Iron and Steel Engineers.
4. The award shall be made at the annual fall meeting following the close of the calendar year.
5. The award shall be made by the board of directors, of the AISE on the recommendation of the executive committee of the AISE.

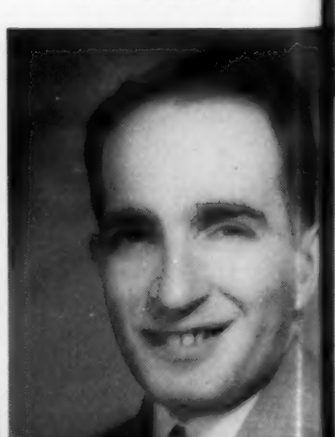
A. J. KROMBHOLZ

F. H. BREMMER

F. J. ZEHNDER



A. E. CICHELLI



for every metallurgical heating need ...

Rust Furnaces

Whatever your needs in melting, reheating or heat treating, there's a type of Rust Furnace to do your job efficiently and economically.

Automatic . . . all fuels . . . easy to operate . . . trouble free. Hundreds of installations, ranging from small to extremely large, attest to Rust's world wide leadership in furnace design and construction.

- OPEN HEARTH FURNACES
- RECUPERATIVE SOAKING PITS
- REGENERATIVE SOAKING PITS
- SINGLE, DOUBLE, TRIPLE-FIRED CONTINUOUS REHEATING FURNACES
- CAR TYPE HEAT TREATING FURNACES
- BOX ANNEALING FURNACES
- CONTINUOUS PIPE ANNEALING
- CONTINUOUS STRIP ANNEALING
- GALVANIZING, WIRE PATENTING
- ROLLER BOTTOM HEAT TREATING
- ORE THAWING, SMELTING, AND OTHER
- SPECIAL FURNACES FOR MANY USES

THE WHOLE JOB IS ONE JOB WITH A "RUST PACKAGE CONTRACT"

One contract covers everything, from original idea to start-up. Rust assumes responsibility for design, manufacture, erection and initial operation. Rust is prepared to undertake these different phases of the work with its own forces. This results in substantial savings to customers, because of only one overhead and profit, instead of the "pyramiding" which occurs when several contractors are used.

24 Pages of furnace Information

Write for your copy

RUST

Rust Furnace Company

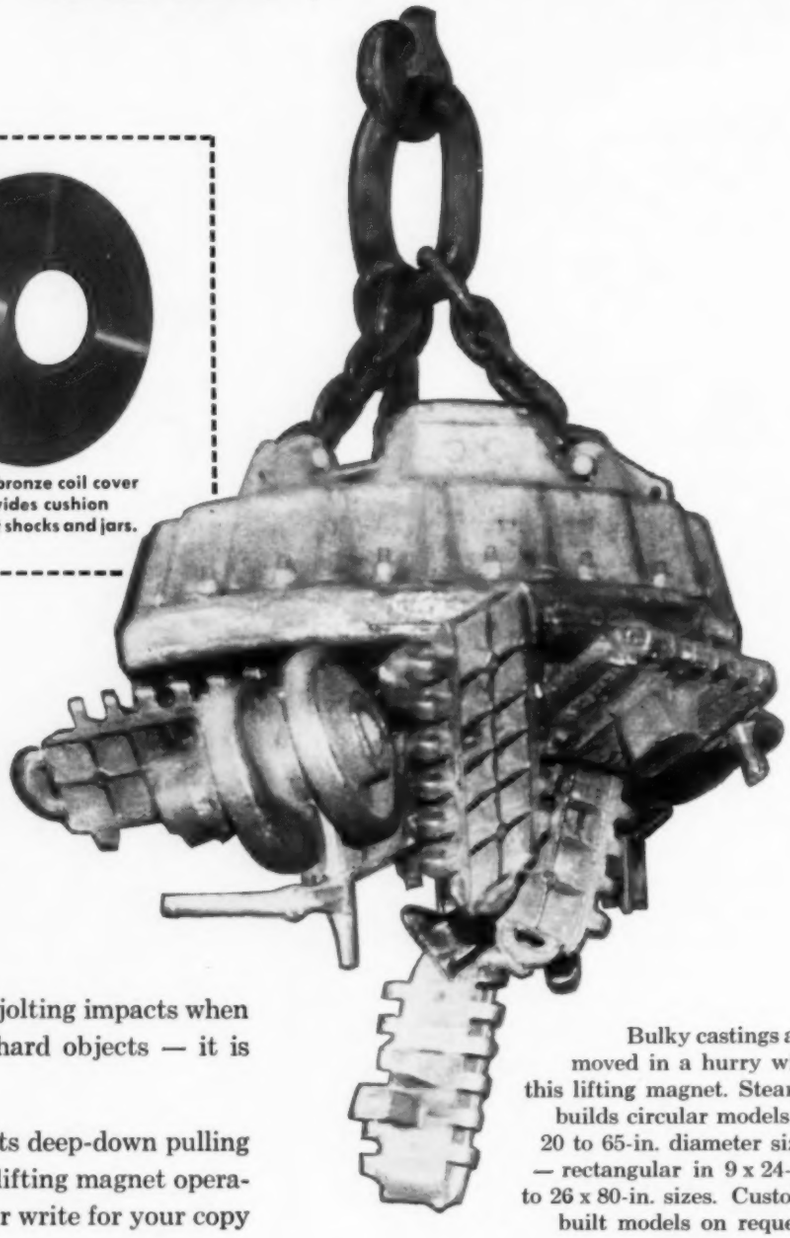
Pioneers in Furnace Design

Rust Building • Pittsburgh, Pa.

Exclusive Built-in Shock Absorber

PROTECTS DEEP-DOWN PULLING POWER

Heavy bronze coil cover provides cushion against shocks and jars.



Bulky castings are moved in a hurry with this lifting magnet. Stearns builds circular models in 20 to 65-in. diameter sizes — rectangular in 9 x 24-in. to 26 x 80-in. sizes. Custom-built models on request.

Powerful, deep-field Stearns lifting magnets are built with an extra wall of protection against shocks and jars. In addition to the regular coil shield of chrome-nickel steel, Stearns adds a heavy bronze coil cover — an *exclusive* feature.

This shock-absorbing cover provides a double advantage—it is both ductile and tough. It not only absorbs jolting impacts when the magnet is banged against sharp, hard objects — it is strongly resistant to damage.

Find out *all* the ways Stearns protects deep-down pulling power — gives you long life, profitable lifting magnet operation. See your Stearns representative or write for your copy of Bulletin 35-B-1.

1078

MAGNETIC EQUIPMENT FOR ALL INDUSTRY

STEARNS MAGNETS

STEARNS MAGNETIC, INC. • 681 S. 28th ST., MILWAUKEE 46, WIS.

U. S. STEEL

Expands Continuous Annealing Facilities

By G. J. HAY
Industry Engineering Department
Westinghouse Electric Corp.
East Pittsburgh, Pa.

▲ DURING the latter part of 1955 the United States Steel Corp. expects to have in operation at their Vandergrift plant of the Irvin works three continuous annealing lines for the processing of silicon steel. The lines are designed to handle strip widths of 18 to 42 in. and strip thicknesses of 0.007 to 0.031 in. The annealing furnaces, furnished with a complete line drive electrical equipment and 6600-volt furnace indoor power centers by the Westinghouse Electric Corp., are designed to have a nominal production capacity of 40,000 lb of 0.014 in. thick by 30-in. wide strip per hour at 460 fpm, on a stress relief cycle and 16,000 lb of 0.014 in. thick by 30-in. wide strip per hour at 184 fpm strip speed on an anneal cycle. The furnaces will be all-electric and will operate at maximum nominal temperatures of 1650 F on the anneal cycle.

These new facilities will provide one course of electrical steel having the high metallurgical qualities required by the electrical industry. In order to obtain these qualities, the speed of the strip through the furnace section must be maintained essentially constant. Storage loops in the entry and exit section permit constant speed during the time in which coils are being changed on the reels. To restore these loops to normal, speeds as high as 625 fpm are available at the entry and exit sections. Magnetic amplifier control of the adjustable voltage generators assures rapid acceleration to running speed and quick stops so that speeds need not be reduced in the furnace section. Current limit circuits measuring load amperes provide for five-second acceleration and deceleration times. Excessive loads cause a rapid, strong, corrective section through the magnetic amplifier to control the accelerating rate. Thus, the entry and exit sections always come up to operating speed as fast as possible, yet accelerating currents are kept within safe limits.

On two of the lines, the design will include a coating unit which will apply a separating medium to prevent sticking during subsequent batch annealing. Provision will be made on the third line for the future addition of the coating unit if production schedules indicate this to be necessary. The design of each line includes, integral with a line drive, an electrolytic cleaning section which insures that no oil, from previous processing, will remain to carbonize and mar the strip during annealing.

Operator's stations, located at strategic points, make it easy for the operating personnel to watch the progress of the strip through the furnace section and to rapidly handle coils at the entry and exit reels. Stations along the entire length of the line will give the operator the right control at the right place which will help to eliminate lost motion and lost time with resultant gain in production.

Time lost for maintenance will be reduced with the improved control. With magnetic amplifier controlled entry and exit generators, the large motor operated rheostats and many relays and contactors normally used in conventional drives are eliminated. Accurate tension control, always essential for good tracking, results from magnetic amplifier current regulators applied to the reels. Equipped with inertia compensation circuits, they keep strip tension constant during rapid accelerations and decelerations. Furnatron regulators will maintain very close temperature control on the critical furnace "soak" section. Photothyratron loop regulators will maintain the normal running loops in the entry and exit looping pits and will aid in restoring loops to normal after a coil change. Thus the full automatic control of temperature, strip tension, loop position, overspeeding and resynchronization, and master line speed will result in minimum lost time, by increased reliability and reduced maintenance, and consequently maximum production on these highest speed silicon steel continuous annealing lines.

INLAND STEEL SOLVES FIREBRICK HANDLING PROBLEM

▲ ONE of the major materials handling problems found in the country's steel mills is cheap, efficient transporation of refractories. Almost every mill uses thousands of tons of brick annually to reline and rebuild open hearths, checker chambers, blast furnaces, soaking pits and re-heating furnaces. This volume alone is enough to cause handling headaches, but the fact that brick is used in hundreds of different sizes makes the problem even more difficult.

Several steel manufacturers have found that the combination of fork-lift trucks and palletization has proved the most efficient and economical solution to the handling problem. Inland Steel, of Indiana Harbor, Ind., has used pallets for several years and has succeeded in establishing a mechanical handling program resulting in substantial man-power savings and greatly increased efficiency when compared to out-dated, manual handling techniques. By palletizing the various sizes of brick and using Clark fork-lift trucks to do the carrying and storing, Inland has reduced manual handling of brick to a bare minimum. An analysis of Inland's methods makes an interesting study.

FIRST STEP — UNLOADING

Brick is received and stored at Inland in three warehouses, one measuring 800 × 100 ft, the second 600 × 45 ft, and the third 350 × 40 ft. Freight cars carrying the material are unloaded under a covered siding extending the length of the warehouse.

The first operation in unloading is stacking the brick on pallets measuring 36 × 42 in. Two men usually do this job. The amount of bricks which can be stacked on each pallet depends on the size of the bricks, but an average would be about 4000 lb per pallet. Empty pallets are stacked on the unloading dock within easy reach of the men unloading the cars. When a pallet is loaded with brick, a fork truck enters the freight car to pick up the pallet and carry it to storage. One fork-lift services three or four freight cars.

One of the advantages realized immediately with the fork truck — pallet method of handling is the huge increase in utilized storage space. Under Inland's previous manual handling system — still employed in some plants today—much warehouse space was wasted, because brick was stored on the floor only as high as a man could reach. With a high-reaching fork truck, however, pallets are tiered four high — approximately twelve feet — thereby doubling the amount of space utilized.

UTILIZE TRAILERS, FREIGHT CARS

The flow of brick in and out of the warehouse varies each day depending on requirements at the open hearths and other parts of the mill. Palletized brick is moved to the job site by trailer or freight car. Trailers are used in carrying the brick to the lower floor of the open hearth for use in

Figure 1 — Step one of "Operation Firebrick" at Inland Steel is the unloading of brick from freight cars. Bricks are stacked on 36 x 42-in. pallets, then removed by fork truck to the storage area. One fork truck services three or four cars.

Figure 2 — When the brick is to be moved to the open hearths, a fork truck carries the pallets to this special trailer designed by Inland. A metal partition divides the trailer lengthwise, with six pallets being stacked on each side. The ends of the pallets rest on a bumper, allowing easy insertion of the lift forks.

trantinyl

guides the steel industry

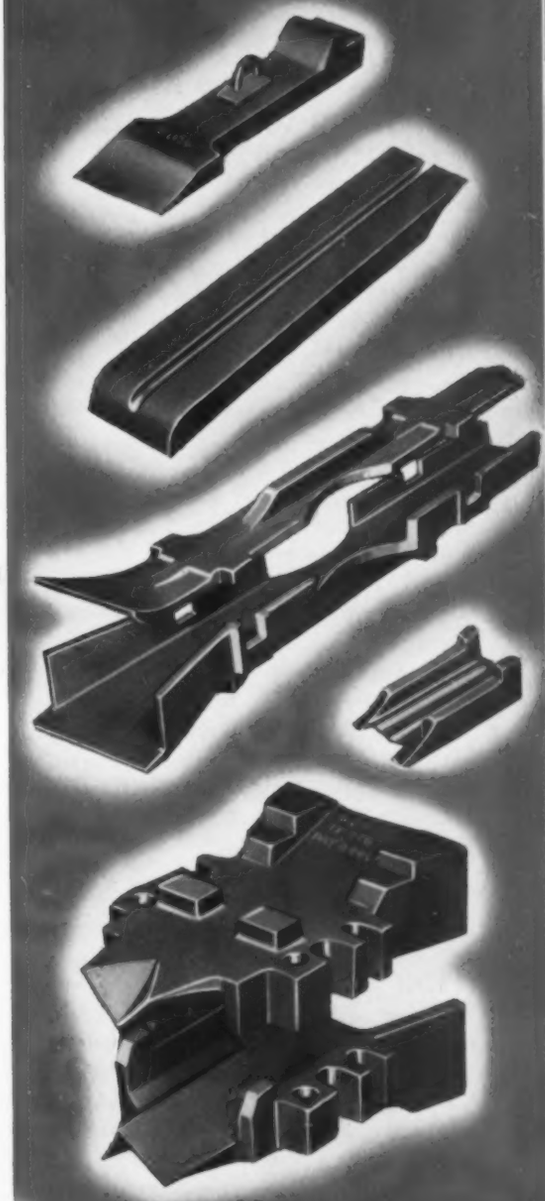
ROLLING MILLS:
bar, hoop, strip, shape
mill guides; and rollers

SEAMLESS TUBE MILLS:
guide shoes, rolling
mill plugs and rolls,
piercer points, etc.

ELECTRIC WELD TUBE MILL:
forming rolls, planishing
rolls, tool holders, etc.

STRAIGHTENING MACHINE GUIDES

HEAT RESISTING CASTINGS



YOUNGSTOWN ALLOY CASTING CORP. • YOUNGSTOWN, OHIO

Figure 3 — Old firebrick is removed from the checker chamber in a tote box, with a fork truck used to carry the box to an outside dumping area. Here the tote box is being lifted from the roller conveyor which carries it into the interior of the chamber. In Figure 4 (above) the powered hand truck is maneuvering a pallet of brick into place near the car door so that the fork truck can remove the pallet to the job site.

rebuilding checker chambers. Freight cars are the means of transportation when the destination is the charging floor of the open hearth, where the brick is used in rebuilding the furnaces.

The truck-trailers used in this operation were specially designed by Inland for the job. The flat-bed trailer is divided lengthwise by a metal partition. Six pallets are stacked on each side of the partition. Each pallet is slightly tilted, with its edge resting on a bumper to provide easy insertion of the lift forks. The trailer is parked either inside or outside the warehouse, freeing the tractor for other duties while the trailer is being loaded by the fork-lift. At the open hearth, another fork truck removes the pallets and carries them to the checker chamber for rebuilding.

OLD BRICK REMOVED

First operation at the checker chamber is the removal of old brick, which is thrown into a tote box resting on a roller conveyor. When the tote box is full, it is pushed to the edge of the chamber, where it can be picked up and removed by fork truck.

When the chamber is cleared, new brick, still on pallets, is brought in by fork truck and deposited near a roller conveyor which carries the bricks to the floor of the chamber for the rebuilding process. When the bricks have been built up to ground level, the roller is placed directly on the bricks, permitting the pallet to be deposited on the roller where it is easily pushed into the interior of the chamber.

Palletized brick for use in relining the furnace proper arrives in freight cars on the open hearth floor and is removed from the car with the aid of a fork truck and a Clark powered hand truck. The fork-lift removes the pallets near the car door first, then hoists the smaller hand truck into the car. The hand truck is used to move pallets from the rear of the car to the door, where they are removed by the fork-lift. When the car is emptied, the hand truck is removed by the fork-lift.

ROLLERS USED IN CHECKER CHAMBERS

The pallets are tiered on the floor until needed for the job, when the fork truck again goes to work and carries the brick to the furnace. From this point the brick is handled on rollers in an operation similar to that used in the checker chamber. As the pallets are emptied, they are stacked near the doors of the furnace for eventual removal by fork truck. Bricks needed for the roof of the furnace are lifted by the fork truck to a long, narrow platform temporarily constructed along the furnace. Laborers pass the brick from the platform to the bricklayers.

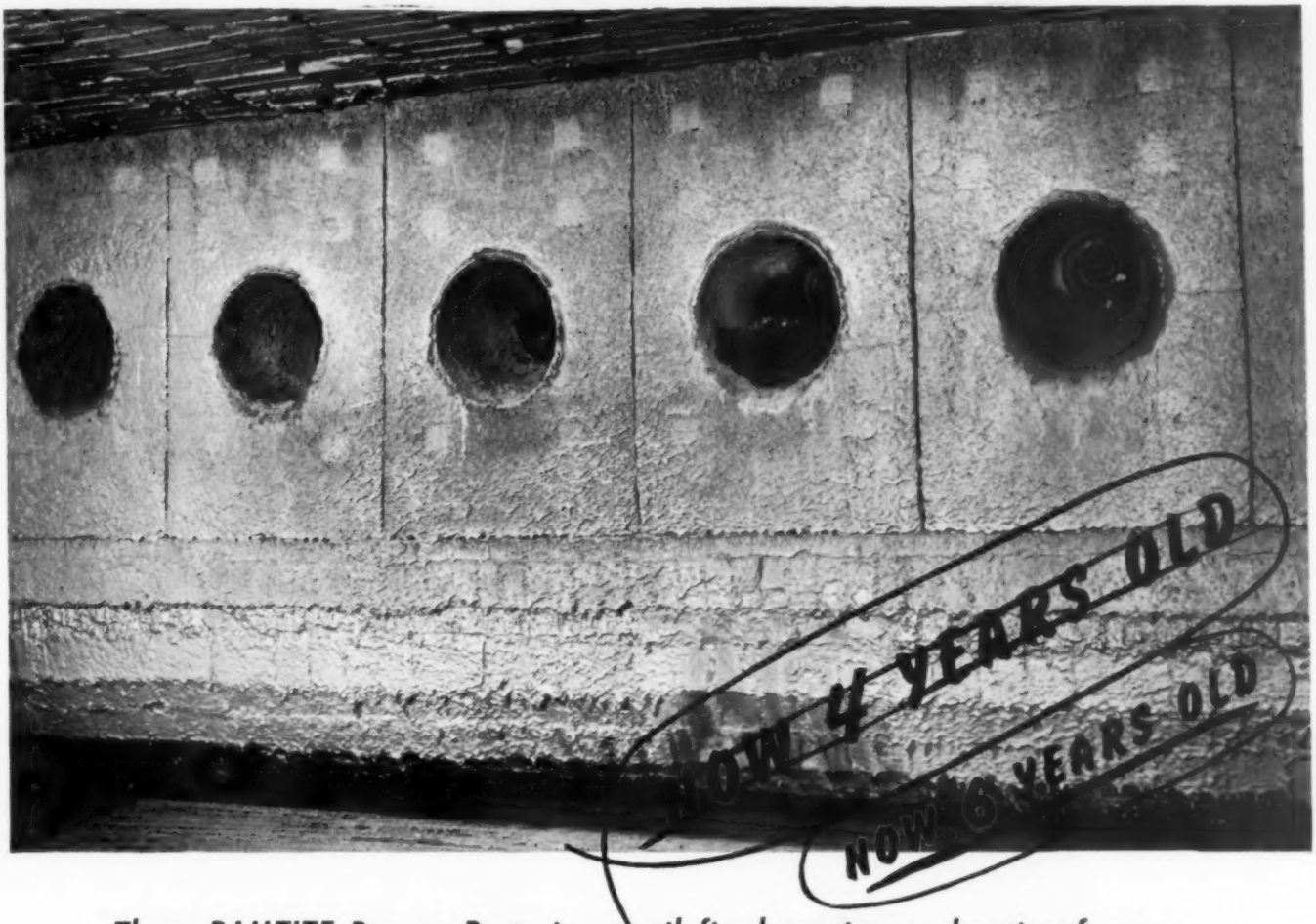
Inland's firebrick operation was planned and put into operation by Company officials. Shortly after the end of World War II — when steel mill condition had returned to something resembling normalcy — a study was made of the brick handling procedures then in use. It was found that the "man and a wheelbarrow" system was becoming more and more expensive but not increasing in efficiency. On the assumption that the volume of brick handled was large enough to warrant a mechanized handling procedure, plant engineers discussed the best method of modernizing the operation. It was decided to try palletization because this procedure offered an economical, efficient solution with a minimum of renovations and changes in plant layout.

GET DRAMATIC RESULTS

The brick handling program has been in operation for almost seven years. Results almost speak for themselves: lower cost, more efficient, faster, less injury, less breakage, and greater utilization of warehouse space. Brick handling has been changed from a problem to one of the most efficient operations in the mill, and is still studied with the idea of further improvement.

"Operation Firebrick" was not a loosely handled, hit-or-miss proposition. It was carefully designed and instigated with specific objectives fully outlined. This thorough planning paid off in dramatic results. The procedures followed by Inland could well be imitated by other mills where refractories handling still causes headaches.

Now you can have Burner Ports that keep their original contours



These RAMTITE Burner Ports in an oil fired continuous heating furnace, after better than three years service, have lasted ~~three~~ SIX times as long as the previous pre-fired Burner Blocks and still have perfect burner cone contour

For maximum fuel and furnace efficiency the ports in a burner wall must be designed in exact accordance with the specifications of the burner manufacturer, otherwise there will be improper flame shape resulting in flame impingement and damage to refractories or to stock.

Why be so careful about burner cone design if they can't be kept correct? Pre-fired burner blocks frequently start to spall and crack soon after going into service. Ramtite won't.

Ramtite field men know the places where Ramtite can be used to best advantage, and how it should be installed. Why not let one of our men survey a troublesome furnace and give you his recommendations?

THE RAMTITE CO.
DIVISION OF THE S. OBERMAYER CO.
1813 S. ROCKWELL ST., CHICAGO 8, ILLINOIS

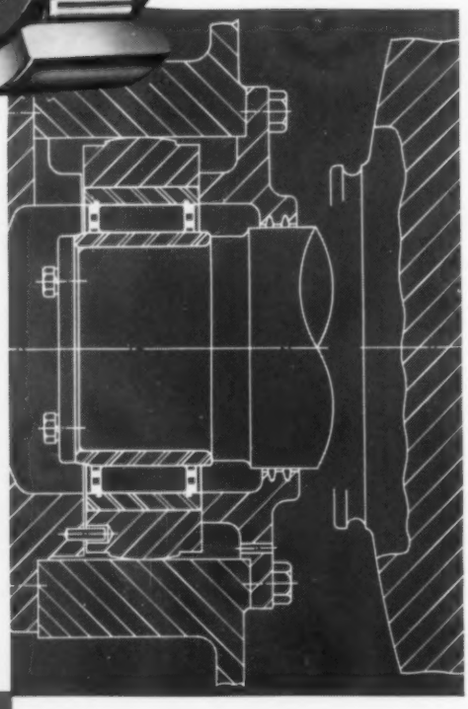
THE **Ramtite** CO.

This is another in a series of advertisements depicting ways Ramtite Refractories serve the steel industry.

Is shaft expansion a problem?

HERE'S HOW HYATTS HELP...

Hyatt Hy-Loads are available in separable outer race, separable inner race or non-separable construction.



Check the drawing at the left. The bearing is a Hyatt Hy-Load, and because the inner race is cylindrical, the shaft it supports is free to move axially—thus allowing for shaft expansion without cramping the bearing or distorting the shaft. Obviously, this is only one of many ways in which Hyatt bearings can be used to reduce costs as they reduce friction, but it's a good example of why so many designers throughout industry keep their Hyatt catalogs within easy reach.

For further details write for Catalog 150 or call your nearest Hyatt representative.

HYATT ROLLER BEARINGS

STRAIGHT BARREL TAPER

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

Restoration Completed on First Ironworks in U. S.

▲ONE of America's earliest industrial landmarks, our country's first successful ironworks, has been completely and authentically restored at Saugus, Mass., 10 miles north of Boston. It was opened as an "outdoor museum" on September 17, 1954.

The colonial ironworks, which dates back to 1646, was rebuilt at a cost of well over $1,000,000 by the American iron and steel industry to dramatize its historical and educational significance. The restoration was sponsored by the First Iron Works Association, Inc., of Saugus.

All of the major units of the 17th century ironworks have been rebuilt. They include the blast furnace, forge, rolling and slitting mill, wharf and a warehouse for storing completed products. Also on the site is the Ironmaster's House which was restored about 1915 by the late Wallace Nutting, artist and photographer of New England scenes.

Although some iron had been made earlier at several points in the United States and Canada, the Saugus ironworks can claim the first successful and sustained production of cast and wrought iron in the New World. A completely integrated ironworks, the Saugus plant was a large-scale enterprise for its day. In many ways it was a prototype of American industry in general. Saugus had its organizers and investors to launch the project and provide capital. It had its trained managers and skilled workmen to develop sources of raw materials and transform them into marketable metal. Established less than 20 years after the initial settlement of Boston and Salem, the pioneer ironworks was soon turning out bar and rod iron and pots and skillets in impressive quantities.

Unearthing the "birthplace" of the American iron and steel industry was a team operation calling upon historian, archeologist, architect and builder. Following clues found by the archeologist and his crew in the ruins of the ironworks, the historian searched the written records for information about the early plant. Recovered relics were accurately measured and examined and the data recorded. From the archeological evidence and from literature on early ironmaking, architects have been able to draw plans for the reconstruction of ironworks buildings on their original sites.

The Saugus Ironworks was created three centuries ago principally through the efforts of John Winthrop, Jr., son of the founder of Boston, and Richard Leader, a merchant of Salehurst, England. Winthrop promoted the plan to develop New England's iron resources while Leader actually established the works.

To finance the project, a group known as the "Company of Undertakers for the Iron Workes in New England," was organized in London. Investors—Englishmen and residents of the Massachusetts Bay Colony — included merchants, ironmasters, lawyers, brewers, civil servants, merchant tailors, a physician and several clergymen. The starting capital was 1000 pounds sterling. Later investments brought the total to about 15,000 pounds, or about $165,000 in today's money. The company was probably the first large-scale capitalistic enterprise of its kind in the American colonies.

The site selected for the pioneer ironworks had a number of natural advantages. Saugus was halfway between Boston and Salem, the two largest settlements. Nearby were ample supplies of bog iron ore, extensive woodlands to supply charcoal, a natural elevation to facilitate charging the furnace from the top, and a navigable stream which could be dammed to provide the necessary water power.

The ironworks, although built in the wilderness of the Massachusetts Bay Colony, utilized the most advanced methods of ironmaking then known. The blast furnace, which operated about 30 weeks of the year, produced just over a ton of cast iron

Figure 1 — The Saugus Ironworks Restoration is a complete and authentic replica of America's first successful ironworks. This historic industrial landmark was rebuilt by America's iron and steel industry at a cost of over $1,000,000.

Figure 2 — The reconstructed 300-year-old blast furnace at the Saugus Ironworks Restoration is built of granite and other local stones. The original 21-ft high furnace produced up to 160 tons of cast iron "sows" (bars) a year. Many of these bars were taken to the forge shown at right and converted into useable wrought iron.

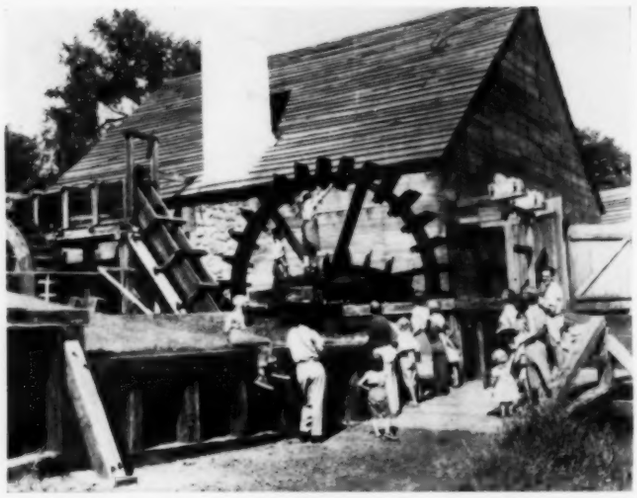


Figure 3 — Visitors at the Saugus Ironworks Restoration look on as guides describe the operation of the forge paddle wheel. This 18-ft water wheel is one of seven which provide the power for the ironworks blast furnace, forge and rolling and slitting mill.

a day. The rolling and slitting mill was one of the few existing in the world at that time.

From the metal smelted in the blast furnace, skilled workmen produced cast iron objects such as pots and firebacks and crude iron sows and pigs. The sows and pigs were carried to the forge, where in finery and chafery operations they were reheated, converted into wrought iron and beaten into bars under a huge water-power-driven hammer. Some of the bars made at the forge went to the rolling and slitting mill, and were worked into flats and rods. From these rods, neighborhood farmers made their own nails, a product in great demand in the growing colony.

Many finished products were sold right at the site. Some were hauled by boat or by cart to meet the needs of smiths and merchants in nearby towns. Others were shipped to a central warehouse in Boston for local sales or shipment overseas.

To operate the ironworks, skilled workers were imported from England. Much of the unskilled work was done by local farmers who worked at the ironworks part time. A number of Scots, who had been taken prisoner by Cromwell's forces in his victory over the Royalists at Dunbar, were also brought over to work out their period of indentured service.

Among the employees of the Saugus works was Joseph Jenks, who operated a mill just below the blast furnace site. One of New England's earliest inventors, Jenks in 1646 obtained America's first mechanical patent for "engines of mils to goe by water." Historians are still puzzled over what operation the "engines" performed.

In addition to turning out a good grade of iron, the Saugus plant provided a training ground for skilled workers in this vitally needed industry. From Saugus, ironmen and masters migrated throughout New England and down the Atlantic seaboard. New ironworks sprang up at Concord, Rowley, Taunton, New Haven and Providence.

In the meantime, however, Saugus ran into difficulties. There was mismanagement by several of the ironmasters. The supply of raw materials began to run out. The new ironworks was unable to meet the competition of imported iron. The managers found themselves in conflicts with local authorities, and it became increasingly difficult to hold skilled ironworkers in a new settlement where farm land was cheap.

About 1670, after years of dwindling operation, the Saugus ironworks was abandoned and fell into ruins.

The First Iron Works Association, Inc., was formed in 1943 to carry on the work of focusing public attention on the site. A few years later Quincy

Figure 4 — Guide in 17th century dress demonstrates the operation of the forge hammer. Three hundred years ago, ironworkers heated cast iron "sows" (bars) in the forge's fineries and chafery and placed them under the forge hammer to be beaten into bars of useable wrought iron.

FERROCARBO

REGISTERED TRADE MARK

by CARBORUNDUM

REGISTERED TRADE MARK

THE LADLE ADDITION
that reduces segregation
and improves quality

For Free Technical Bulletin
Call your nearest Distributor:

KERCHNER, MARSHALL & CO.
PITTSBURGH • Cleveland • Buffalo
Philadelphia • Birmingham • Los Angeles

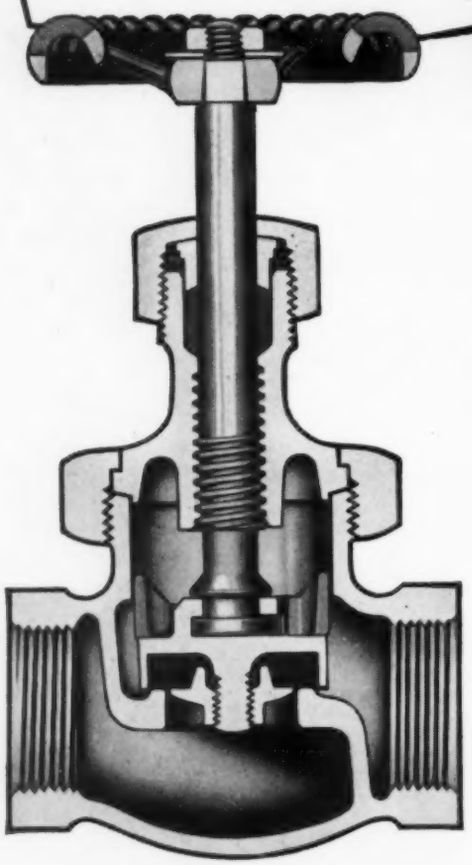
MILLER & COMPANY
CHICAGO • St. Louis • Cincinnati

WILLIAMS & WILSON
TORONTO • Montreal • Windsor

OR write to
The Carborundum Company,
Dept. 84, Niagara Falls, N. Y.

• In Canada, "Carborundum" and "Ferrocarbo" are registered trademarks of Canadian Carborundum Company, Ltd., Niagara Falls, Ontario

A New Disc . . .
A "New" Valve



Crane No. 7 Brass Valves with quick-change composition disc

Save time, trouble, and money by standardizing on these Crane quality 150-Pound Valves. Simple to service. No big inventory of replacement parts. Just a few extra disc holders . . . a supply of composition discs. That's all you need for a wide variety of fluids . . . and an economical maintenance program.

The composition disc takes most of the normal wear—stands up well under ordinary usage—seats easily even on air and gas—absorbs foreign particles that might cause leakage in metal disc valves. When a leak shows up, make a "new" valve—with a new disc. Simply dismantle the union ring, lift out the trimmings, replace the disc holder assembly. Takes only a few minutes. Save the disc holder you removed—use it with the next replacement disc.

Rugged construction throughout. Sturdy bonnet joint, well reinforced by heavy union ring—can be repeatedly dismantled and reassembled. Get better acquainted with the Crane No. 7 line . . . for steam, hot and cold water, air, oil, gas, gasoline, and many other fluids.

GLOBES, ANGLES, AND CHECKS

Ask for folder AD-1682R—contains full facts on the No. 7 brass valve line and the companion No. 27 check. Your Crane Representative has a copy for you—or write direct to address below.

No. 7 Globe
Sizes ⅛ to 3-inch

No. 7 Angle
Sizes ⅛ to 3-inch

Specify No. 9 for Flanged Ends

No. 27 Check
Sizes ¼ to 3-inch

THE BETTER QUALITY . . . BIGGER VALUE LINE . . . IN BRASS, STEEL, IRON

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

Bent, a retired steel executive and summer resident of nearby Cape Ann, attended one of the meetings. Recognizing the ironworks as Americana of prime significance, he discussed the project with officers of the Association. As a result of this meeting, he passed on to the Board of Directors of American Iron and Steel Institute what was then known about America's first successful ironworks. After studying the information the Institute's Board assured financial support for restoration work.

Shortly thereafter, Archeologist Robbins was engaged. He began investigating the grass-covered mound which proved to be the old slag dump, and soon uncovered the remains of the blast furnace. The search went on until other main features of the ironworks were disclosed.

One of the most important finds during excavation was a water wheel, 16 feet in diameter, which furnished power for the bellows of the blast furnace. Covered with moist earth, which undoubtedly preserved the old oak and pine boards, the remains of the wheel were discovered in 1951. They were lying 21 feet below the surface of a main street, less than 10 feet from the stone furnace.

But finding the wheel was only half the job. It then had to be removed and measured so a workable replica could be made. Once taken from its mud bath the wheel began to crumble and disintegrate. Experts from Harvard University were called upon and Professor Elso S. Barghoorn of the biology department quickly developed a unique preserving process. Sections of the wheel were carefully removed, wrapped in water-soaked burlap and rushed to the Harvard laboratories where they were placed in large vats of melted paraffin wax. During a three-hour heat treatment the water in the wood vaporized and was replaced by the wax. The wax was allowed to cool and harden, leaving the treated sections almost as solid as the day they were made.

Figure 5 — In the original rolling and slitting mill, wrought iron bars were reheated and run through a set of rollers operated by two huge water wheels. Some of the flats, as the pig iron plates were called, were made into shovels, saws and other tools. Other flats were run through a pair of slitters which formed rods used in nailmaking.

While the archeological crew sifted the ruins of the ironworks for physical evidence of the ancient plant, an intensive study was being made of the ironworks' records and of the lives of people who played a part in it. During this research Professor Hartley and his colleagues examined thousands of documents, many never printed.

From these scattered bits of evidence it is possible to put together a picture of economic life at Saugus three centuries ago. Records show that in 1651, the ironworks produced 160 tons of cast and wrought iron, that this cast and wrought iron sold for about $200 and $275 a ton respectively, in today's money, and that the ironworks normally had about 30 customers. We know that the 26 stockholders (Company of Undertakers) invested up to $165,000 in the ironworks and that the 80 employees (skilled, unskilled, part-time, full-time), averaged about 12 cents an hour for a 12-hour day, a relatively high wage for the period.

During the past 300 years, America's iron and steel industry has had a tremendous growth. From the modest plant on the banks of the Saugus River the industry has spread across the nation and become a major economic and social force in the life of every American. Today, steel is made or finished by 255 companies which operate 430 plants in 270 communities in 31 states. For raw materials, steelmen turn to every continent in the world. More than 600,000 workers are employed at some 1200 jobs and the savings of almost 800,000 stockholders are helping to finance this $9,000,000,000 industry. During 1953, the steel industry produced almost 112,000,000 tons of ingots and steel for castings, or, 700,000 times the production of iron at Saugus in 1651.

VERTICAL TIN PLATE ANNEALING FURNACE LINE TO GO TO WALES

▲ THE first Drever continuous vertical tin plate strip annealing furnace line to be built in Europe has been ordered from the Incandescent Heat Co., the Drever Co. English associates, by the Steel Co. of Wales for strip up to 38 in. wide and 0.0075 to 0.020 in. thick with an output of 16½ tons per hour, at temperatures up to 1350 F. Line will be radiant tube gas-fired. This equipment will be installed in the Velindre Works and is expected to be in operation by 1956.

Strip being processed enters the 10-strand controlled atmosphere furnace through gas-tight entry roll seals and is heated to the annealing temperature of 1350 F in the first five heating passes.

After heating to the proper top temperature, the strip enters the two-strand soak section for temperature equalization. The soak section will be electrically heated with heating elements of heavy nickel-chromium ribbon resistors.

Following the soaking section, the strip is directed through three controlled cooling passages where a uniform temperature drop of from 1350 to 800 F is accomplished.

Final cooling to below the oxidizing temperature is accomplished by pas-

sage of the strip through 16 vertical cooling chute sections. The strip leaves the controlled atmosphere cooling section through gas-tight exit roll seals at a temperature of approximately 250 F.

Two forced air cooling chute passes are included to further cool the strip to approximately 150 F before entering the No. 3 bridle unit. To provide necessary time for welding, an entry and exit looper will be supplied. The furnace structure is 49 ft 0 in. overall height, 8 ft 2 in. wide center to center of furnace columns and 26 ft 2 in. long center to center of end columns.

A Continuous Billet and Slab Grinding Line

By JAMES MacGREGOR
Board Chairman
York-Gillespie Manufacturing Co.
Pittsburgh, Pa.

▲ A continuous billet and slab grinding line for grinding alloy steel products on a production basis has been developed by York-Gillespie Manufacturing Co. of Pittsburgh. The new equipment revolutionizes the antiquated methods of hand swing frame grinding by substituting modern high speed, dust free production units complete with automatic feeding devices and inspection tables.

The grinding line, as shown on Figure 1, consists of an automatic billet or slab feeder, grinder approach and runout tables, and grinders complete with an inspection table that mechanically rotates the product through 360 degrees for the inspector, and deposits the product into a two-position cradle car. The feeder unit is automatically controlled by the product passing through the grinder. When the end of the product enters the grinding machine, the front end of the product trips a limit switch that automatically operates the feeder unit which deposits another piece of product onto the grinder delivery table. The product is fed through the grinder by a specially designed feeding type set of pinch rolls, which motivates the product after each stroke of the grinding wheels.

Grinding of the product is performed on two sides simultaneously, by two 18-in. diam × 2½-in. wheels independently driven by 25-hp motors. All grinding is performed under water sprays, which collects the dust and delivers it to a sump for reclamation, thus eliminating the filtration of grinding dust into the area and the need for dust exhaustion systems. The stroke of the machine can be adjusted within the unit to correspond with the product size. Wheel pressure is applied hydraulically and can be set by controls on the operator's control pulpit to a pre-determined percentage of product removal as determined by the metallurgical department. A slight over-run of the stroke permits the wheels to close slightly below the normal width of the product being ground, thereby permitting the machine to grind corners.

The combination of water sprays on the wheels at the product, combined with a slight agitation of the wheels proper during grinding, keeps them clean and prevents them from blocking. The water sprays also keep both the product and the wheels cool during the operation, thereby increasing the wheel life. The combined design feature of the new grinder permits quick wheel changing when required.

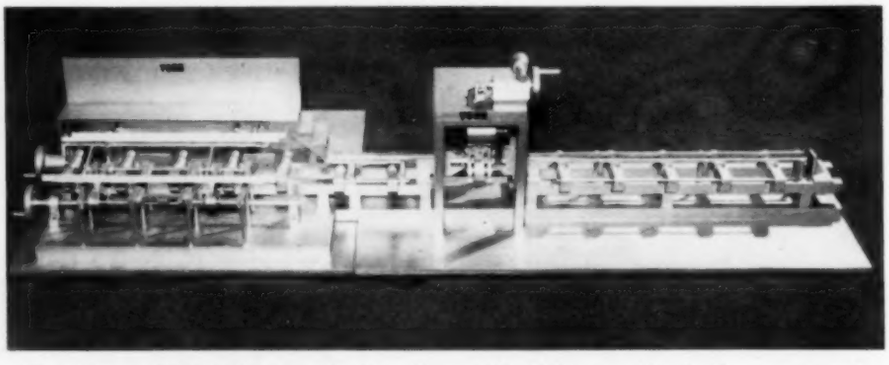


Figure 1 — Model shows grinding line with billet or slab feeder, approach table, grinder, runout table and inspection table.

Announcing **New, Re-Designed**

Arktite

HEAVY DUTY

PLUGS & RECEPTACLES

NEW pressure connectors; no soldering unless you prefer to do it.

NEW easier-to-wire interior assembly; comes out in one piece—just remove 2 screws.

NEW easier-to-interchange plug and receptacle interiors; no machining; no special tools.

NEW plug adaptability; takes any size portable cable up to full 30 amp. capacity.

Circuit-Breaking Features Make Arktite Safe at Full Load Without Disconnect Switches

Each contact is insulated in a separate chamber. Arcs formed while making or breaking circuit are snuffed out in arcing chambers by pressure-deionization and lack of oxygen. No chance of flash-over even if break is made at full load. With grounding contacts longer than load contacts, plug and tool are grounded *before* circuit is made and *after* it is broken.

New *Arktites* now available in 30 amp. size — 2-pole, 3-pole and 4-pole styles. Fully interchangeable with old *Arktites* — *same economical price.*

SEND FOR FREE BULLETIN

OR SEE YOUR CROUSE-HINDS DISTRIBUTOR.

A NATIONWIDE DISTRIBUTION exclusively through ELECTRICAL DISTRIBUTORS

CROUSE-HINDS COMPANY

SYRACUSE 1, N.Y.

CONDULETS • FLOODLIGHTS • TRAFFIC SIGNALS • AIRPORT LIGHTING

HOW TO CUT COSTS

WHEN THE HEAT'S ON →

USE

ROCKBESTOS® AVC

(NEMA TYPE AVA) CONTROL CABLE

Here's your best protection against shutdowns in Steel Mill and Industrial Plant hot spots. Rockbestos AVC is built to beat the heat and corrosive fumes.

You get long life — more dependable service under severe operating conditions because the individual conductors are insulated with walls of impregnated felted asbestos — to permanently resist heat, moisture, and mechanical damage . . . as well as to effectively seal the high dielectric varnished cambric tapes from any deterioration.

Install Rockbestos AVC and see how it reduces maintenance and operating costs — keeps your production dependably on the go. Once you've tried it, we believe you'll always insist on Rockbestos AVC.

Rockbestos will engineer and build special multiconductor cable constructions for any specific applications you may have.

ROCKBESTOS PRODUCTS CORP.
NEW HAVEN 4, CONNECTICUT

NEW YORK • CLEVELAND • DETROIT • CHICAGO
PITTSBURGH • ST. LOUIS • LOS ANGELES
OAKLAND, CALIFORNIA • NEW ORLEANS • SEATTLE

TANDEM COLD MILL COMPLETES REBUILDING PROGRAM AT ALLEGHENY LUDLUM

▲ Allegheny Ludlum Steel Corporation officially completed a nine-year rebuilding and expansion program today when Edward J. Hanley, president, pushed the button that put into production a new tandem cold rolling mill at the company's Brackenridge, Pa., plant on September 28. The four-stand mill makes it possible for the company to offer regularly to the trade 48-in. wide coils of cold rolled electrical and stainless steels. The use of this width material often makes it possible for fabricating industries to improve their efficiency with increased output and reduced waste.

The mill will also be used for the production of the company's other high alloy specialties. Complete auxiliary equipment for continuous annealing, pickling, and shearing have also been installed to complete the processing of these materials.

The company has spent $96,000,000 on its modernization and normal plant replacement program since the end of World War II. Much of this has been spent to convert the company's production from sheets to coils, in keeping with an industry-wide trend. A 56-in. single-stand reversing cold mill completed in 1951 is particularly well adapted to the company's production of stainless steel coils, and permits the flexibility of rolling schedules characteristic of that business. The mill just put in production, being especially suited for longer production runs, will be particularly useful for the production of silicon steel.

The new cold rolling mills, along with the equipment installed in the entire corporation program, were engineered to handle the tough rolling problems encountered in the handling of Allegheny Ludlum's high alloy products. Silicon steel is tough and brittle, susceptible to edge cracking and breakage, and requires exacting control of tension in cold rolling. Stainless steel, in turn, is a special rolling problem as well.

The modification and adaptation of all steel mill equipment to the particular requirements of the company was done under the direction of Emil Kern, vice president, engineering. Construction work for all projects was also carried on under the direction of his staff.

The production of large coils, up to 12,000 pounds, in these new mills, makes it possible for the company to offer improved products, in terms of surface condition, gage control, and control of physical characteristics, as well as improved service due to shorter production cycles.

MILL DESCRIPTION

The mill was built by Mesta Machine Co., and all major electrical and control equipment was furnished by General Electric Co. The mill is

Figure 1 — A 40-in. blooming mill performs the first rolling operation on stainless and electrical steels produced at the Brackenridge plant of Allegheny Ludlum Steel Corp. The mill was installed as a part of the company's postwar modernization program.

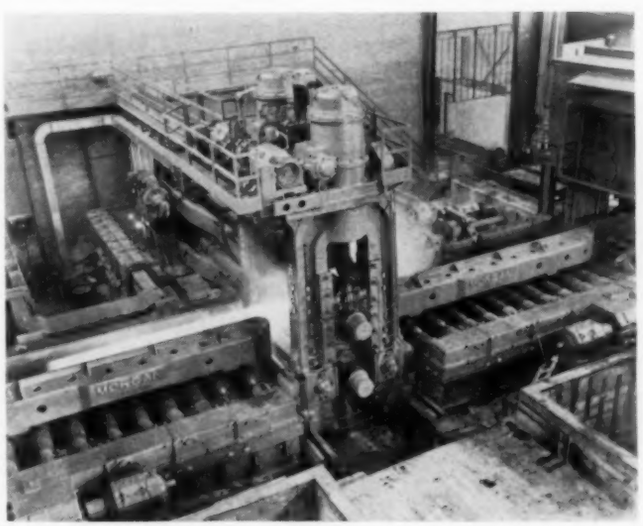


Figure 2 — A hot extrusion plant installed at Allegheny Ludlum Steel Corp.'s Watervliet, N. Y., plant produces seamless tubing of stainless steel and other high alloy materials, and also produces a wide variety of shapes from the same materials. The process uses glass as a lubricant.

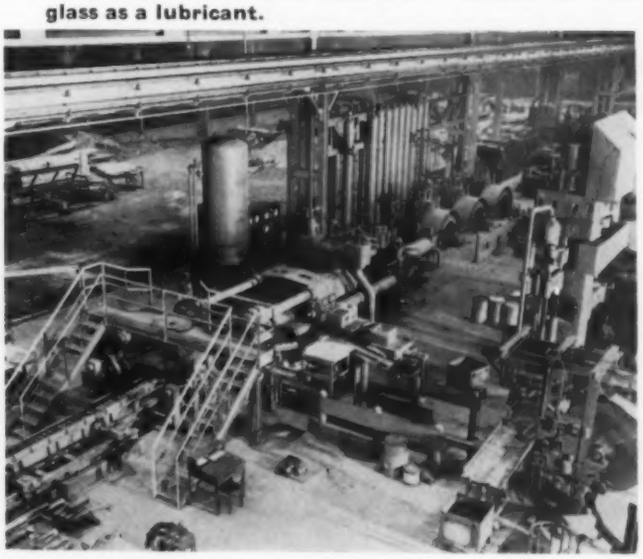


Figure 3 — Largest single installation in the Allegheny Ludlum postwar expansion program is a 56-in. semi-continuous hot strip mill at the Brackenridge, Pa. plant. The six finishing stands are shown here.

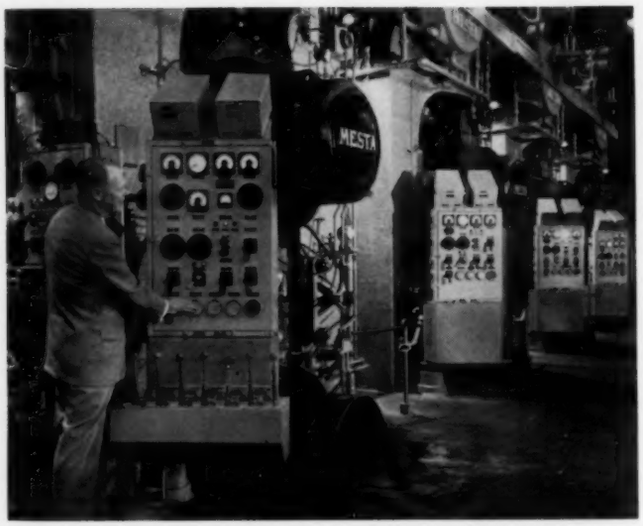


Figure 4 — Edward J. Hanley, president of Allegheny Ludlum Steel Corp., officially started production on the new 56-in. 4-stand tandem cold mill at the Brackenridge, Pa. plant on September 28.

capable of rolling 300,000 tons of stainless, silicon, and alloy steel annually. It will operate at speeds up to approximately 2000 fpm.

While the new mill ultimately will have a total of 15,000 hp, it is being being broken in with 7500 hp. All four stands and the tension reel of the mill will be powered with direct-drive, double-armature motors operating under adjustable voltage control. At present, however, only a single armature is installed on each stand and reel. Source of power is one motor-generator set consisting of: (1) one 1000-kw, two 1600-kw, and one 400-kw generator, all 600 volt d-c; (2) 125-kw generator and one 50-kw generator both of 250 volt d-c. The drive motor for the set is a 9000-hp, 6600-volt, 514 rpm synchronous motor.

The unusual feature of this drive is the fact that power for each motor armature is supplied by a separate generator. With the installation of the second armature, it should be noted that the two armatures will be supplied by two generators on the two motor-generator sets respectively. The armature circuit of each motor and its generator is entirely isolated from the other. In case of failure of any motor or motor-generator set, the mill can continue to operate on at least half the total connected horsepower.

The payoff reel is arranged so the mill can be used with only stands No. 3 and 4 in operation. The tension reel motor is rated at 1000 hp, 100 rpm with only half of the horsepower presently installed.

The large rotating electrical apparatus is located on the mill floor and is ventilated by an up-draft, non-recirculating system using cooling air, drawn by fans, through glass filters.

The control system uses a combination of 60-cycle magnetic amplifier-rotating type of regulating equipment. More than 2500 hp of small auxiliary a-c and d-c motors are included in the drive equipment installed in this new mill. Included in the power distribution equipment are one 10,000-kva, 2516.6-kv transformer, one 1500-kva, 6600/480-volt transformer, and metal-clad switchgear.

AUXILIARY EQUIPMENT IN THE COLD FINISHING DEPARTMENT

There are one 48-in. and two 40-in. slitting, leveling, and inspection lines for processing silicon steel. Each line has a feed reel, slitter, scrap baller, leveller, inspection table, and winding reel. Speed is 200 to 600 fpm with an output of 6 to 9 tons per hour for each line.

There is a 50-in. shot blast cleaning, pickling, and side trimming line for processing silicon and stainless steels. Line speed is 50 to 250 fpm.

One silicon strip normalizing line has a combination gas fired electric roller hearth type furnace. Line speed is 69 to 180 fpm with an output of approximately 26 tons per hour. Three strips, simultaneously, side by side, pass through the furnace.

Major plant improvements since World War II are listed as follows:

Brackenridge Plant
- 4-furnace electric melting department
- 50-ton electric melting furnace
- 40-in. blooming mill and soaking pits
- 56-in. semi-continuous hot strip mill
- 56-in. cold reversing mill
- 56-in. 4-stand tandem cold mill
- 56-in. skin pass mill
- 56-in. continuous pickle and anneal lines
- Normalizing and slitting lines
- Additions to laminations department
- Miscellaneous shearing lines

Watervliet Plant
- 3-furnace electric melting department
- 22-in. blooming mill
- Hot extrusion building and facilities

Carmet Division
- Carbide powder manufacturing plant
- New powder forming presses
- New sintering furnaces

Research Department
- All-Stainless research building
- Additions to research facilities

Arnold Engineering Co. (Subsidiary)
- 6-in. cluster-type rolling mill
- Building and facilities for magnetic core production
- Equipment for electronics parts manufacture
- Hydrogen heat treating furnaces

West Leechburg Plant
- 28-in. 4-stand tandem cold rolling mill
- Two 30-in. reversing cold mills
- 42-in. skin pass mill
- Pickle and annealing lines
- Batch and continuous controlled-atmosphere annealing furnaces
- Nitrogen and hydrogen generating plant
- Expansion of grain oriented strip production
- Numerous other processing lines

Dunkirk Plant
- Building and production facilities for stainless wire and rods
- Company-owned and government-owned fine wire drawing equipment

Buffalo Foundry
- Modern electric melting furnace
- Additions to casting plant and sand cleaning and handling equipment

Wallingford Steel Co. (Subsidiary
- Electro-weld tube mill
- 27-in. reversing cold mill
- 10-in. reversing cold mill
- 34-in. skin pass mill
- 27-in. Sendzimir cold mill

HARBISON-WALKER

Announces

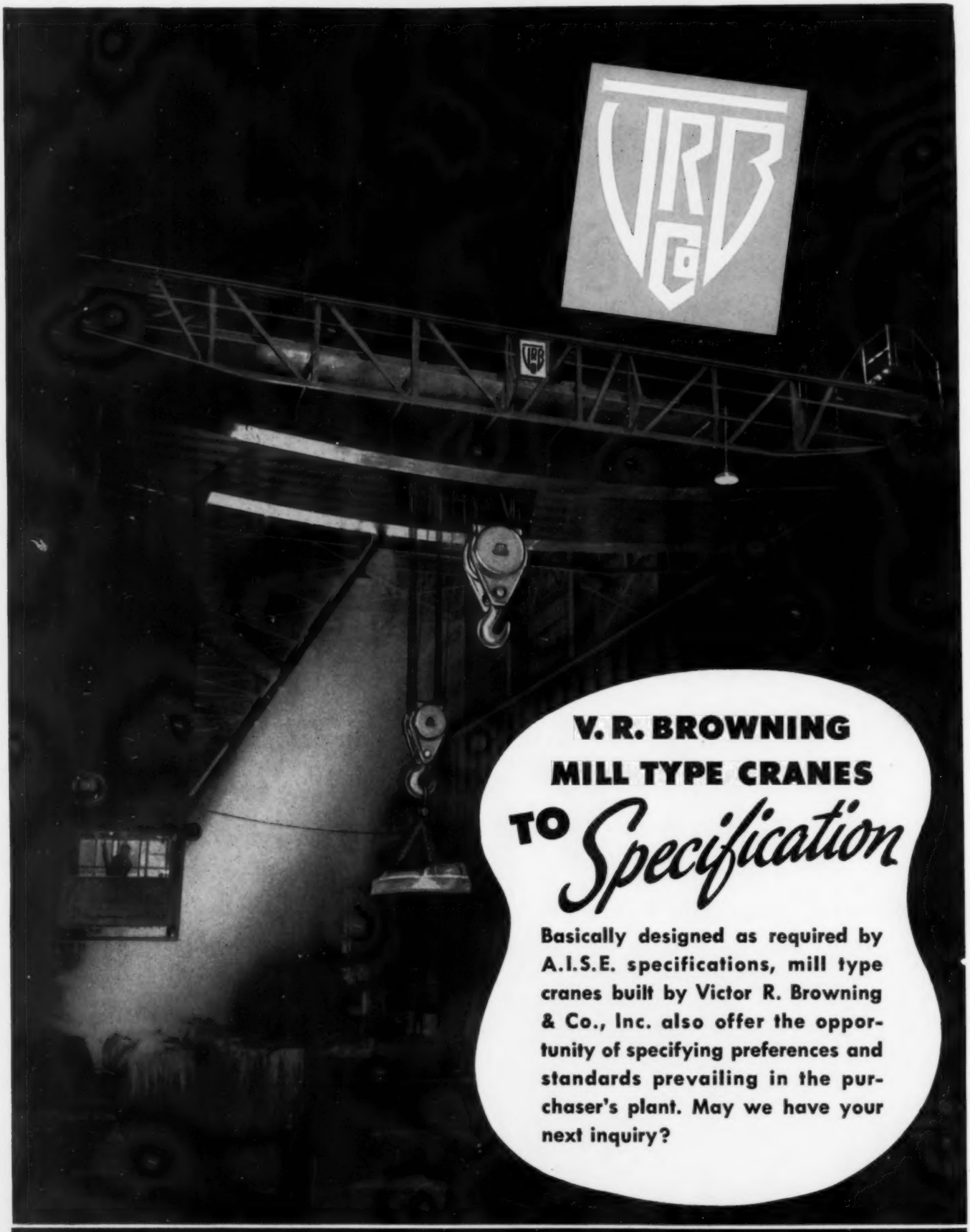
H-W C-MIX

(Seawater Magnesite Mixture)

A NEW 92% Magnesia Ramming Mixture for open hearth furnace bottoms

- **HIGH STRENGTH**
  Over 4000 psi crushing strength after heating to 2910°F.
- **HIGH DENSITY**
  172 lb. per cu. ft. (rammed)
- **LOW SHRINKAGE**
  Less than 1% when reheated to 2910°F. (ASTM C 113-46)
- **MADE FROM HIGH-PURITY SEAWATER MAGNESITE**

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES
World's Largest Producer of Refractories
GENERAL OFFICES **PITTSBURGH 22, PENNSYLVANIA**


V. R. BROWNING
MILL TYPE CRANES
TO Specification
Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

VICTOR R. BROWNING & COMPANY, Inc.

BOX 309, WILLOUGHBY (CLEVELAND), OHIO

Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

Electronic Brain

CONTROLS WORLD'S LONGEST SINGLE-FLIGHT CONVEYOR BELT!*

*11,000-foot rubber belt in mile-long conveyor handles coke between coking plant and blast furnaces at large eastern steel mill.

In this installation, the NEO-TIME-CURRENT ELECTRONIC ACCELERATOR (in white circle) is shown on an EC&M 150 h.p. 440-volt starter.

EC & M AUTOMATIC ACCELERATOR MODIFIES TIME BY MOTOR CURRENT TO COMPENSATE FOR LOAD AND WEATHER CONDITIONS

THE EC&M NEO-TIME-CURRENT METHOD OF ACCELERATION is not just time limit or current limit . . . it actually combines the advantages of both to give positive acceleration modified by load conditions. As its name implies, it is inherently self-adjusting and automatically provides for (1) fast acceleration of an empty belt on a hot day and (2) slow acceleration of a loaded belt under icy conditions.

NEO-TIME-CURRENT STARTER FEATURES:

1. It permits use of single motor-drive on long conveyors.
2. Belt stretching is controlled within safe limits during acceleration.
3. Convenient adjusting dials can be set for slow start during break-in period and then gradually changed to give most efficient acceleration for best operation.
4. After tune-up, further manual adjustment is eliminated by automatic self-adjusting characteristic of the Neo-Time-Current.

For Details and Specifications, Write Today for Booklet 1041.

E&M

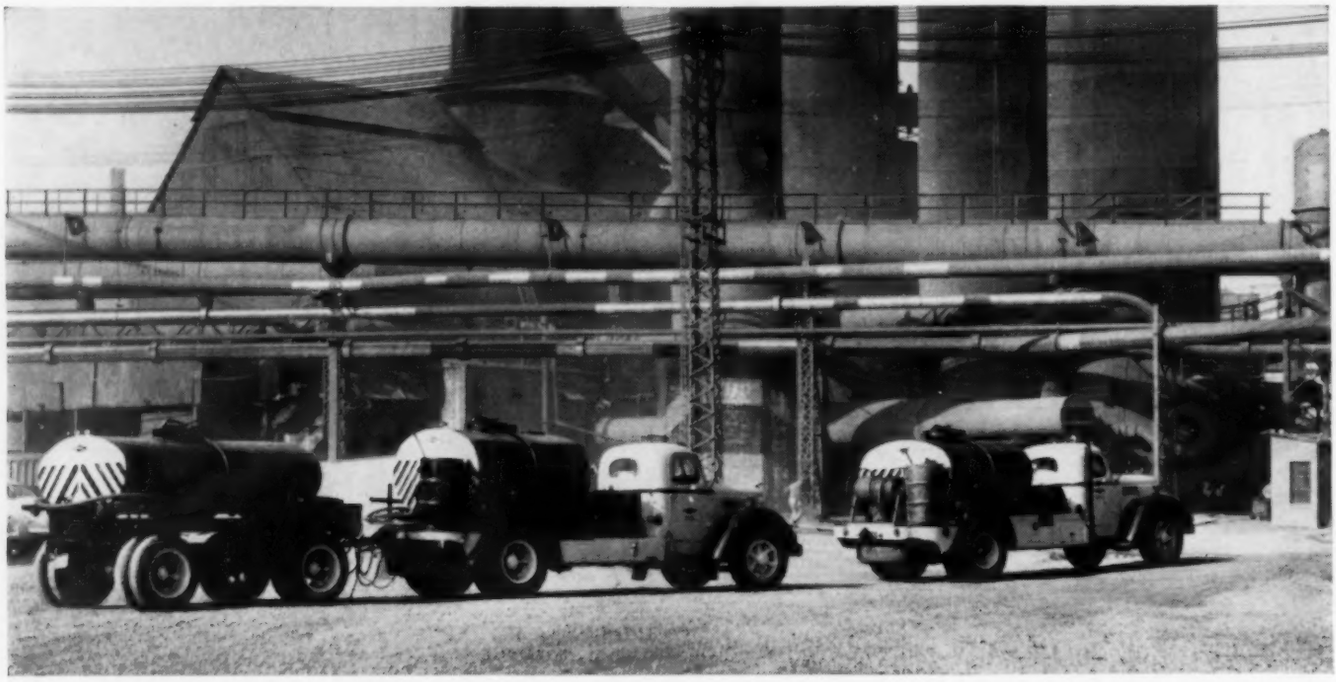
THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET • • CLEVELAND 4, OHIO

1758

600 FEET OF COKE OVEN GAS MAIN CLEANED CHEMICALLY WHILE IN USE

DOWELL-designed jet nozzle removed brittle deposits from 30-inch gas line under pressure



Tar and naphthalene deposits had accumulated in a 600-foot section of a steel company's 30-inch gas main. The line supplied coke oven gas to a strip mill two miles away. Pressure drop through this line had doubled, forcing the company to buy large quantities of natural gas to supply the strip mill. The company's attempts to clean the line with steam and hot water failed . . . then Dowell was called.

Dowell Service cleaned the line in only three working days, using chemical solvents, specially-designed high-pressure jets and mobile high-pressure pumps. The steel company was especially pleased because Dowell Service did not interfere with the regular function of the line.

What about your maintenance problems? Dowell engineers are experienced in the chemical cleaning of boilers, blast furnace cooling systems, stoves, water lines, gas washers and many other types of steel plant equipment. Dowell engineers use special pump trucks and control equipment to apply liquid solvents by filling, spraying, jetting, cascading or vaporizing. No scaffolding is required. Dismantling and downtime are kept to a minimum. Some equipment can be cleaned in operation.

For more information on Dowell Service and how it can be used to your advantage, call the nearest Dowell office. Or, write directly to Tulsa, Dept. J-29.

DOWELL SERVICE

Over 100 Offices to Serve You with Chemical Cleaning for:

Boilers • Condensers • Heat Exchangers • Cooling Systems
Pipe Lines • Piping Systems • Gas Washers • Process Towers
Process Equipment • Evaporators • Filter Beds • Tanks

Chemical Services for Oil, Gas and Water Wells

DOWELL INCORPORATED • TULSA 1, OKLAHOMA

DOWELL

A Service Subsidiary of
THE DOW CHEMICAL COMPANY

Date-line Diary...

September 2

▲ Installment credit buying in July rose $124,000,000 over June to a total of $21,200,000,000. This was $242,000,000 above July 1953, according to the Federal Reserve Board.

September 3

▲ U. S. Steel Corp. closed down two of its soft coal mines in southwestern Pennsylvania temporarily because output is not needed to keep up with present rate of steel operations.

September 6

▲ The AISI reports operating rate of the steel industry for the week starting September 6 is scheduled at 62.9 per cent of capacity. This is equivalent to 1,500,000 tons compared with 1,525,000 tons one week ago and 2,011,000 tons one year ago. Index of production for the week is 93.4.

September 7

▲ Trading in the world's first futures market for scrap iron and steel started this morning on the Chicago Mercantile Exchange.

▲ Purchases of zinc boosted the price ½¢ a lb, the first hike since June.

▲ Construction expenditures climbed to a record at $3,600,000,000 in August, according to the Commerce and Labor Depts. This was 3 per cent above July and 8 per cent above August one year ago.

September 8

▲ Lead had advanced ¼¢ to 14½¢ a lb in St. Louis.

▲ The American Trucking Assoc. reported that truckers handled 4.2 per cent less inter-city tonnage in the June quarter than in the corresponding period in 1953.

September 9

▲ The Government reduced its estimated 1954 production of cotton to 11,832,000 bales, 848,000 under its forecast one month earlier. Cotton futures rose as much as $2.05 a bale following this report.

September 10

▲ According to the Securities and Exchange Commission and the Commerce Dept., business outlays for new plants and equipment in 1954 will drop to $26,700,000,000, about 6 per cent below last year's $28,400,000,000.

▲ After a three month inspection through Ford Motor Co. plants abroad, Henry Ford II foresees a decline in U. S. exports to Western Europe.

▲ July dividends to stockholders paid about 9 per cent less than in the corresponding month in 1953 according to the Commerce Dept.

▲ Barium Steel Corp. announced that a substantial majority of the shareholders have approved the increase in authorized capital stock from 2,500,000 to 5,000,000 shares.

▲ The Aluminum Association reported primary production of aluminum in July 1954 totaled 252,323,794 lb in comparison with 241,516,343 lb in June 1954 and 218,570,626 lb in July one year ago.

September 11

▲ Electro Metallurgical Co., a division of Union Carbide and Carbon Corp., revised prices on silicon alloys and special alloy products because of an increase in wages and higher prices for basic raw materials.

▲ Contract awards for future construction in the 37 states east of the Rockies totaled $1,576,865,000, up 11 per cent over August of 1953 and a new record according to the F. W. Dodge Corp.

September 13

▲ A report from The Aluminum Association showed August primary aluminum production in the United States totaled 250,592,575 lb in comparison with 252,323,794 lb in July and 221,090,007 lb in August 1953.

▲ The AISI reports operating rate of the steel industry for the week starting September 13 is scheduled at 66.3 per cent of capacity. This is equivalent to 1,580,000 tons compared with 1,502,000 tons one week ago and 2,060,000 tons one year ago. Index of production for the week is 98.4.

September 14

▲ Republic Steel Corp. has been negotiating the purchase for some of the steel mill equipment at Follansbee, W. Va. from F. W. Richmond of New York. The mill is part of the Follansbee assets which Richmond arranged to buy for $9,000,000.

September 15

▲ The H. K. Porter Co., Inc. offered stockholders of the Laclede-Christy Co., in St. Louis $19.75 per share for their stock.

▲ The Budget Bureau has put out revised figures predicting Federal spending in the year ending next July 1 will be $64,000,000,000, about $1,600,000,000 below that estimated last winter. Income will drop $3,400,000,000 to $59,300,000,000.

▲ Westinghouse is hopeful that its sales in 1954 will surpass their 1953 record. In the first six months of 1954, they netted $2.75 a common share compared with $2.19 in the corresponding 1953 period.

▲ Westinghouse Electric Corp. and the International Union of Electrical Workers agreed on a new two-year contract. Under this contract, the employees will receive wage and salary increases averaging around 5¢ per hr and increased pensions. A threatened strike was then called off.

▲ As of July 31, inventories of manufacturers, wholesalers and retailers totaled $77,500,000,000 reported the Commerce Dept. This was $8,000,000 under the previous month and $2,700,000,000 below the figure one year ago.

▲ General Motors expects the nation's production of goods and services to reach $360,000,000,000 this year.

▲ Rotary Electric Steel Co. cut its base prices $2 to $3 a ton on certain alloy and carbon bars and alloy billets.

▲ U. S. Steel is contemplating building a multi-million dollar plant at its Geneva Works in Utah to produce steel pipe for oil and gas transmission.

▲ Bethlehem Steel Corp. booked a $6,900,000 contract from the Delaware River Port Authority for a viaduct superstructure on its new $90,000,000 toll bridge.

September 17

▲ The Steel Co. of Canada, Ltd. hiked its basic steel prices between $2 and $3 a ton.

▲ The ARCI reported deliveries of new domestic freight cars in August 1954 totaled 2297 compared with 1801 in July and 5557 in August 1953. August orders totaled 2425. Backlog of cars on order as of September 1, 1954 was 13,013 compared with 12,889 on August 1.

September 20

▲ The AISI reported production of alloy steel in August at 549,089 net tons or an increase of 59,259 tons over July. Total steel production in August was 6,666,907 tons of ingots and steel for castings, an increase of 39,310 tons over July.

▲ The AISI reports operating rate of the steel industry for the week starting September 20 is scheduled at 66.6 per cent of capacity. This is equivalent to 1,588,000 tons compared with 1,583,000 tons one week ago and 2,144,000 tons one year ago. Index of production for the week is 98.9.

▲ Ford Motor Co. increased its dividend payments from $10 in 1951 and 1952 to $15 a share in 1953.

▲ The ICC ordered motor transport firms to increase their hauling charges by 16 to 33 cents per 100 lb or up to railroad levels on mixed freight in truckloads between the East and Midwest or within the East. Any lower truck rates were found to constitute destructive competition.

September 21

▲ U. S. Steel Corp. will go ahead with a new steel pipe plant at its Geneva works near Provo, Utah. It is expected to employ over 200 workers and will produce electric weld pipe for oil and gas transmission.

▲ Pittsburgh Steel Co. announced it will start up the No. 2 blast furnace at its Monessen works on October 1 because of an increase in orders.

September 22

▲ A $100,000,000 pipeline system is planned by four companies which will extend through the Rocky Mountain, Arizona and New Mexico regions.

▲ U. S. Steel Corp. and Bethlehem Steel Co. announced new social insurance programs which will provide $350,000,000 in benefits to steelworkers and their families in the next two years.

▲ According to the Commerce Dept., new business placed with producers had totaled between $22,500,000,000 and $23,000,000,000 a month since March, a contrast to the previous 12 months when new orders fell from almost $26,000,000,000 to a low well under $22,000,000,000.

▲ The president approved a plan to send 10,000,000 tons of coal to undeveloped areas of the world particularly Africa and southeast Asia.

▲ Shipments of iron ore from Canadian mines were 3.9 per cent below July one year ago and total shipments of 2,586,190 tons for the seven months were down 21 per cent.

September 23

▲ Spot copper on the London metal exchange held the highest level since August 1953. It advanced 1⅛¢ to the equivalent of 33⅛¢ a lb.

▲ A $101,000,000 expansion program is planned by General Motors over the next five year period for its British plant, Vauxhall Motors, Ltd.

▲ McLouth Steel Corp. began operation of its new blast furnace at Trenton, Mich. as a step in its $105,000,000 expansion program.

▲ Housing starts in August were 19 per cent above one year ago.

▲ Alcoa announced that it had reached agreement with the UAW (CIO) members on a two-year contract covering 3500 workers at four Alcoa plants. The new contract calls for a 5¢ hourly wage increase, improvements in pensions and insurance.

September 27

▲ On sales of $250,235,696, the Colorado Fuel and Iron Corp. and its subsidiaries earned $7,051,729 for the fiscal year ending June 30, 1954 in comparison with sales of $248,835,574 and earnings of $8,031,224 for the preceding fiscal year. Net income in 1954 was equivalent to $2.46 per share of common stock as compared with $3.09 per share in 1953.

▲ The AISI reports operating rate of the steel industry for the week starting September 27 is scheduled at 68.9 per cent of capacity. This is equivalent to 1,642,000 tons compared with 1,637,000 tons one week ago and 2,149,000 tons one year ago. Index of production for the week is 102.2.

▲ August shipments of fabricated structural amounted to 268,032 tons, which is 8 per cent above July, as reported by the AISC. August bookings were 190,498 tons. Total shipments during the first 8 months of 1954 were 2,137,797 tons or at the rate of 3,206,700 tons for the year. Backlog of work ahead as of August 31 stands at 1,369,692 tons.

▲ Machine tool orders in August picked up from the four-year low in July. Business advanced to $43,300,000, a $6,800,000 gain over July.

September 29

▲ Youngstown Sheet and Tube Co. will reactivate its Brier Hills Works which has been idle for over two weeks to work off inventories.

September 30

▲ Chrysler Corp. was awarded a $160,000,000 contract from U. S. Army to construct Patton M-48 medium tanks. This contract will return Chrysler to its position as one of the major tank builders. Its defense volume for the first half of 1954 fell to $152,000,000 from the $375,000,000 in the corresponding period in 1953.

▲ Bethlehem Steel Co.'s proposed merger with Youngstown Sheet and Tube Co. has been disapproved by the Justice Dept. and attorney General Brownell threatened to bring suit against both companies if they go ahead with their plans.

▲ Steel scrap prices in Pittsburgh were advanced $1.50 a ton, to the highest level for the year.

▲ According to the AISI, total estimated payroll of the iron and steel industry in August was $238,778,000 against the $232,796,000 in July. Average hourly payroll cost of wage earners was $2.356 in August compared with $2.368 in July. Employment in the industry fell to 601,400 in August compared with 607,600 in July. Employees worked an average 35.1 hours a week in August compared with 33.4 hours in July.

Twenty ton mill type bucket crane with 75′ span built to A.I.S.E. #6 specifications, over the slag crushing plant in a large eastern steel mill.

20 Ton Bedford Mill Type Crane in slag crushing plant

The Bedford crane illustrated was designed for extra severe duty bucket mill type service — built strictly to A.I.S.E. #6 specifications. It uses a 3 cu. yd. capacity 4 line bucket. It is equipped with mill type 600 series motors, Tool Steel gears, pinions and wheels—forged steel flange type couplings are used throughout except all motor couplings are flexible type. The bridge is equipped with four two-wheel compensating trucks. The cab is equipped with safety glass on two sides, and each window is protected on the outside by sliding steel shutters to protect the operator from explosions in the pit. The cab floor is insulated to protect the operator from high temperatures in the pit.

The big swing to Bedford Cranes is evidenced by the high percentage of repeat orders from experienced crane users who require and *expect* superior performance.

Backed by more than half a century of *specialized* crane engineering and fabricating experience . . . Bedford Cranes have won fame the world over for advanced design and for safe, smooth, dependable performance.

Available in all types and sizes . . . from 5 tons to 350 tons . . . for all kinds of indoor and outdoor service . . . each Bedford Crane is individually engineered for its specific application.

Consult a Bedford engineer on your next crane problem . . . with all the facts on the table we believe you too will make your next crane a Bedford.

(Write for complete catalog describing Bedford Cranes in detail.)

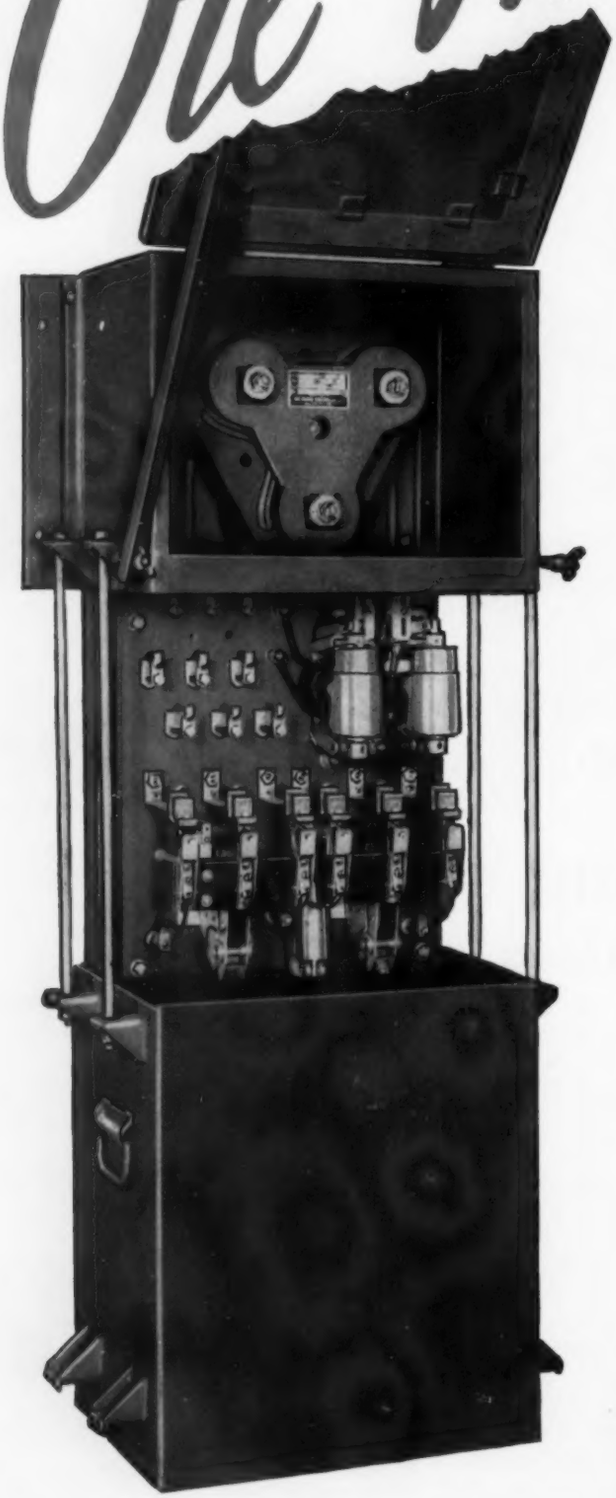
STEEL MILL CRANES BEDFORD

New York Office: 280 Madison Avenue
New York 16, N. Y., Phone MUrray Hill 5-0233

Pittsburgh Office: Oliver Building, Room 1241
Phone ATlantic 1-0136

BEDFORD FOUNDRY & MACHINE COMPANY, INC. • BEDFORD, INDIANA

Oil Immersed



Type 900-B, Frame 100, Reduced Voltage Starter of the Impedance Type

REDUCED VOLTAGE STARTER OF THE IMPEDANCE TYPE

900 Series

Push button operated — fully automatic — Rowan 900 Series, oil immersed, reduced voltage starters of the impedance type give your induction motors a smooth start with a minimum of line disturbance.

The 900 Series starters include such features as: a closed transition, utilizing for acceleration a combination of voltage and time; an acceleration period dependent upon driven equipment and load, which eliminates the human element; continuous wound impedance coil assures freedom from tap failures — impedance is adjustable to each application; magnetic overload relays provide a combination of inverse time element and instantaneous operation.

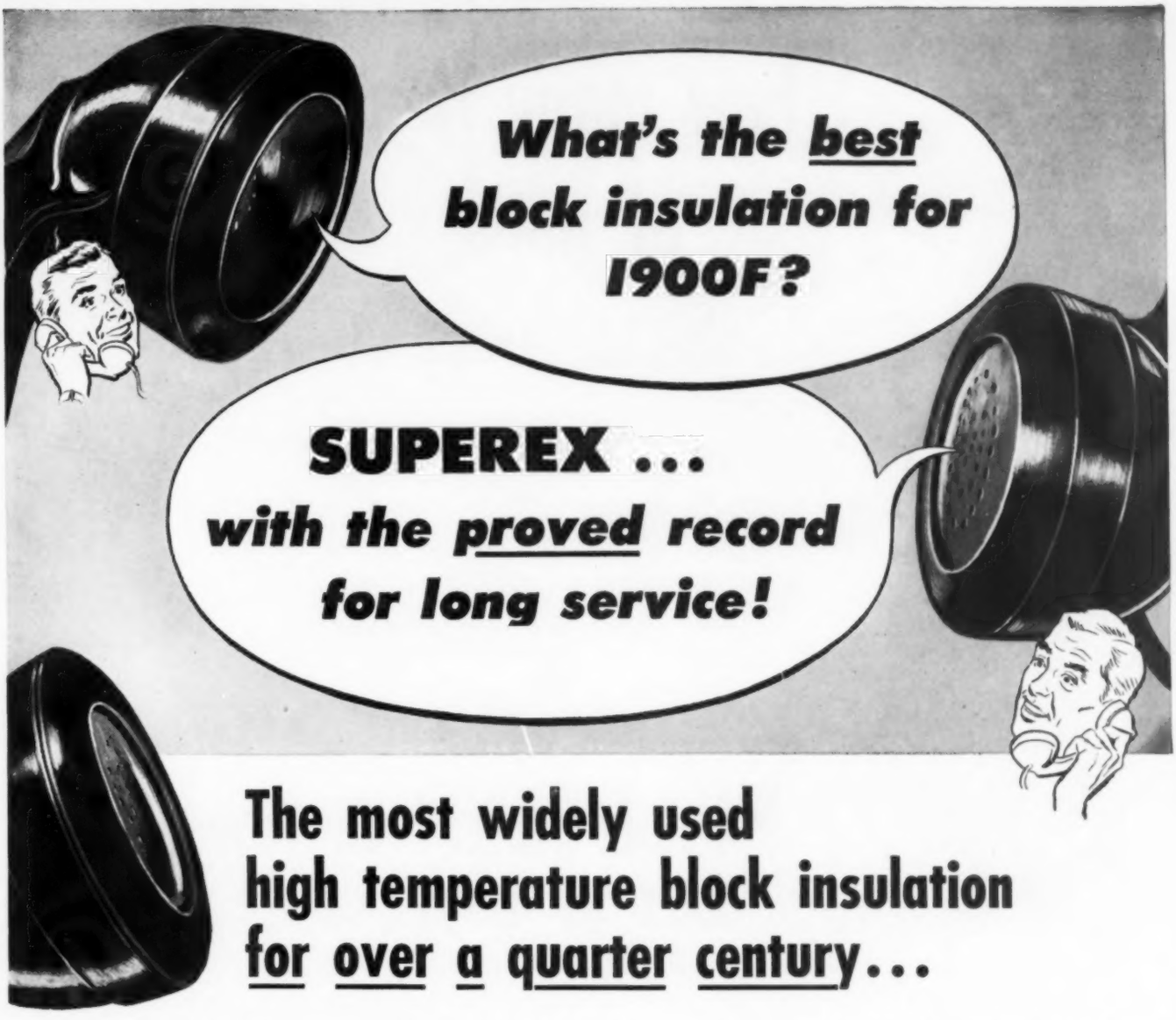
Combination starters include: Rowan time-tested **AIR-SEAL** fuses providing dependable short circuit protection; sealed-off centralized wiring compartment; provision for straight through conduit connections; tank and disconnect mechanism mechanically interlocked to prevent the lowering of the tank before disconnecting the line disconnect switch.

Enclosures are of weather-resistant design to meet **NEMA Type XI** requirements and are available also for **NEMA Type VIII**, Class I Group D locations.

New booklet available — describes the 900 and other series of Rowan Oil Immersed Motor Starting Equipment up to 4600 Volts.

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.



The most widely used high temperature block insulation for over a quarter century...

SUPEREX® high temperature block insulation has long been industry's No. 1 choice for service temperatures up to 1900F. It provides *major* economies . . . reduces fuel costs, cuts heat losses, keeps maintenance expense down, costs less to install and has long service life.

These are the reasons why 90% of the nation's hot blast stoves are Superex insulated . . . and why the low cost open hearth steel producers use Superex in their regenerators.

Made of specially selected and calcined diatomaceous silica blended with other insulating materials and bonded with asbestos fiber, Superex will safely withstand temperatures up to 1900F with negligible shrinkage.

Superex has been used with outstanding success in all types of industrial and metallurgical furnaces and ovens, stationary and marine boilers, auxiliary power plant equipment, regenerators, kilns, roasters, high temperature mains, flues and stacks.

Superex has all these important advantages...

Low thermal conductivity—Exceptionally high heat resistance (1900F) combined with excellent insulating value.

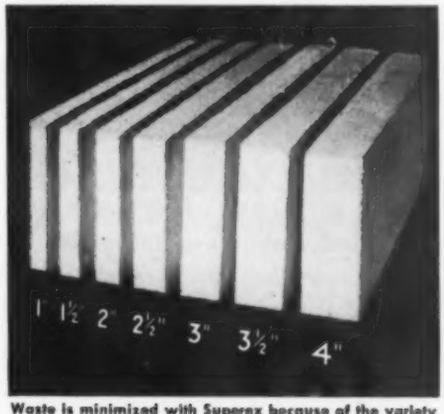
Light weight—Approximately 2 lb per sq ft per in thickness.

Great physical strength—Approximately 6 tons pressure per sq ft are required to compress Superex ⅛ in.

Long, efficient service life—Superex maintains high insulating value indefinitely—will not disintegrate in the service for which it is recommended.

Fast, easy application—Superex may be cut with an ordinary knife or saw for fitting around openings or to irregular surfaces. Because of its light weight and convenient sizes, Superex assures fast and economical installations.

For complete information about Superex block insulation, write for Brochure IN-134A. Address Johns-Manville, Box 60, New York 16, N. Y. In Canada, write 199 Bay Street, Toronto 1, Ontario.



Waste is minimized with Superex because of the variety of thicknesses available. Special shapes and intermediate thicknesses between those shown are also available.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville *first in* **INSULATIONS**

how many thousands of dollars do these tools cost you ?

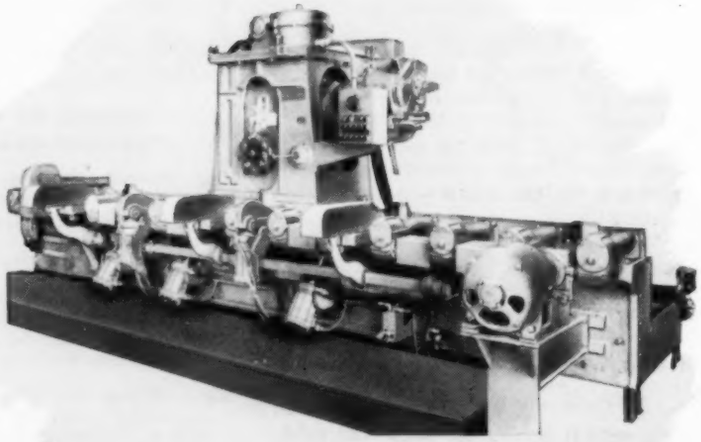
You can buy hammers and torches for a few dollars and operate them for a few quarters a day. BUT, consider the additional thousands of dollars these tools cost you in . . .

High per-ton conditioning labor cost • Loss of valuable chips • Excessive remelting • Heavy inventories necessary to maintain schedules • Disruption of rolling schedules • Manpower turnover • Production loss through accident and fatigue.

BONNOT BILLETEER CAN SAVE YOU THESE THOUSANDS OF DOLLARS

Finger-touch controlled Bonnot Billeteer converts multi-horsepower force into *smooth high-precision operation*. It provides a dependable flow of conditioned billets without dangerous, nerve-racking drudgery and all the "extras" that make manual conditioning costs especially prohibitive in view of Bureau of Labor Statistics figures showing LABOR COSTS UP 157% SINCE 1939.

Bonnot BILLETEERING does a better job ten times faster at a saving of 56% . . . and makes the billetshed a preferred place to work. Let us show you how many thousands of dollars the Billeteers can save in your mill.

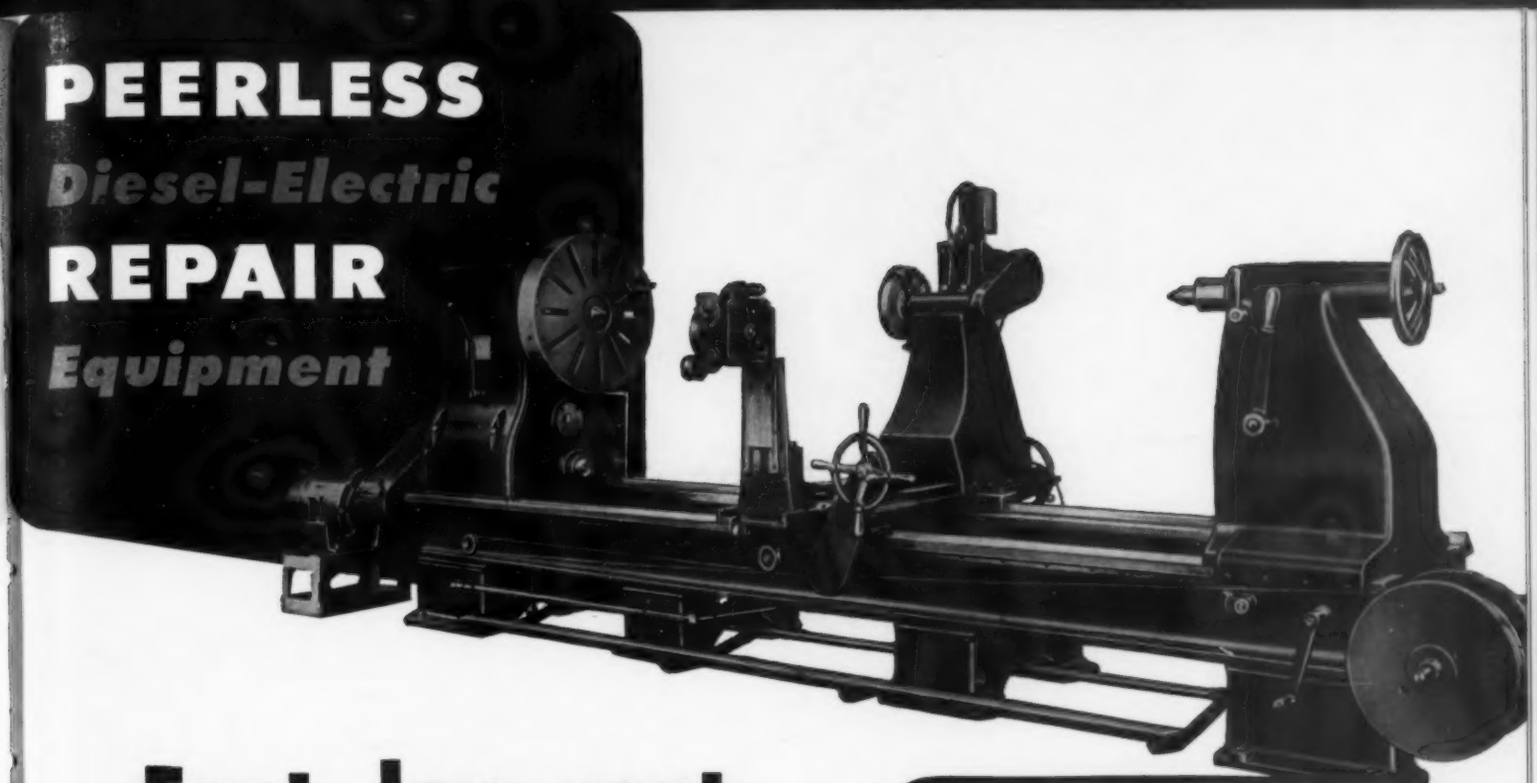


Engineered For Improved Production

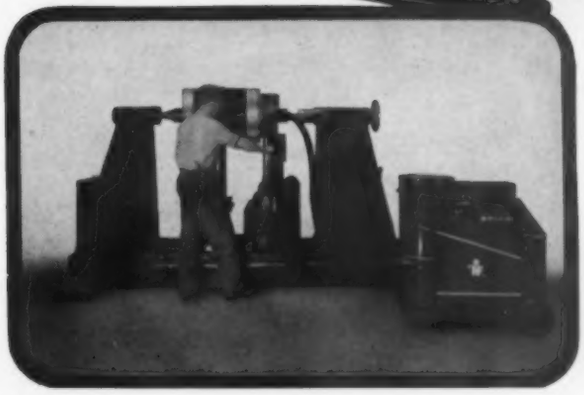
The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO

Also Manufacturers of — SAWING • PULVERIZING AND MIXING EQUIPMENT • BILLET INSPECTION TABLES
CRUSHING • DUST PUG MILLS • SINTER PLANT PUG MILLS

PEERLESS
Diesel-Electric
REPAIR
Equipment



Fast, low-cost, efficient repairs on Armatures, Commutators



Peerless Universal Armature Machine (top) with Commutator Grinding Attachment, Standard Banding Tension Device. (Below) Peerless Type DS Undercutter with Vacuum mica dust collector.

THE PEERLESS Universal Armature Machine and the Commutator Undercutter are the heart of a cost-cutting modern Diesel repair shop. Look what you get with these extra-heavy duty, multi-purpose machines . . .

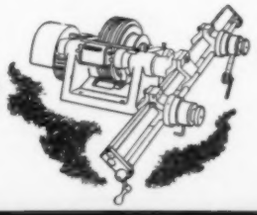
4 REPAIR OPERATIONS WITH UNIVERSAL ARMATURE MACHINE: Bands armatures up to 48″ dia.; turns, grinds and undercuts commutators up to 35″ diameter.

FAST, PRECISION RESULTS WITH TYPE DS COMMUTATOR UNDERCUTTER: Undercuts traction-motor and generator armatures with diameters up to 60″, shaft lengths to 72″, weights up to 9,000 lbs. Commutators with maximum face of 18″, diameters 6″ to 42″ can be cut on this machine. Send for Complete Details, Prices.

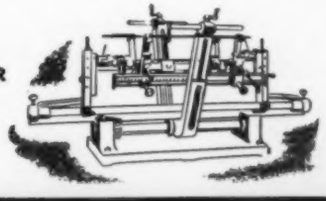
Cost-Cutting Tools for Coil-Winding by PEERLESS

PEERLESS LATHE HEAD, LOOP WINDER. High-speed coil production for all standard armature, transformer, stator, control, field, and similar coils. PEERLESS COIL SPREADER. Eliminates one-third of usual coil-forming operations. Easy to operate. PEERLESS COIL TAPER. For all types and sizes of armature coils. Tapes a coil a minute!

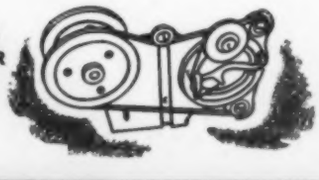
LATHE HEAD & LOOP WINDER



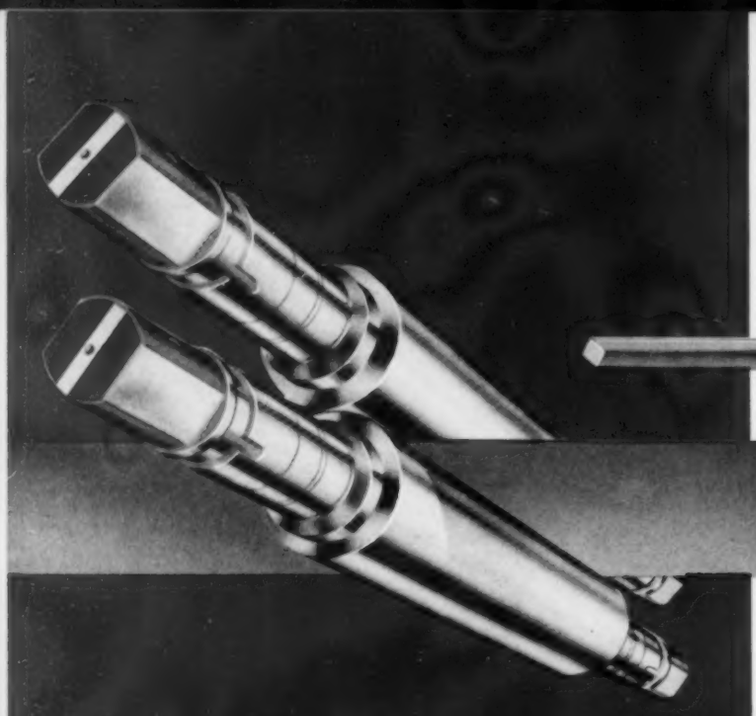
COIL SPREADER



COIL TAPER



ELECTRIC SERVICE MANUFACTURING CO.



Whatever you roll...

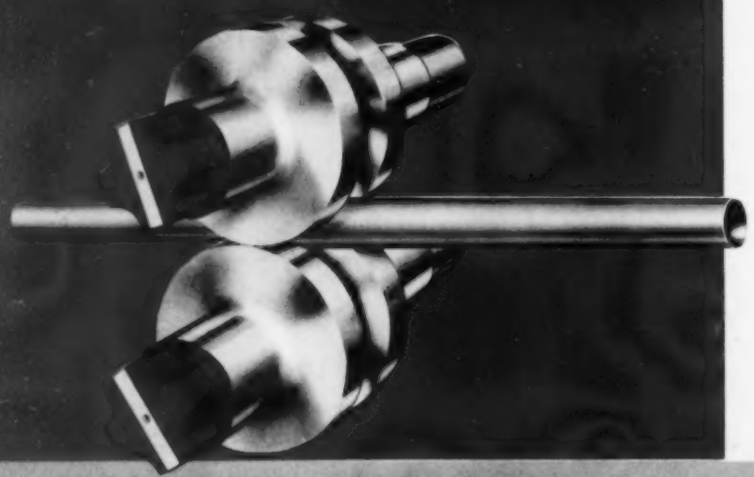
MACK-HEMP

STRIPED RED WABBLER ROLLS

fit the mill—and fill the bill

Take Mack-Hemp's specialized roll making experience signalized by many firsts in metallurgical and manufacturing advances—and you get rolls that do the job better and faster, stand up longer and turn out products of the quality you are proud to stamp with your name.

Combine it with Mack-Hemp's 150 years of Know-How service to the metals industries with the skill of your own engineers and you get assured productioneering that pays off in your rolling mills.



It's a good habit to always keep an eye on what's new and different at Mack-Hemp.

MACKINTOSH-HEMPHILL
COMPANY

Makers of the Rolls with the Striped Red Wabblers

PITTSBURGH AND MIDLAND, PA.

MACKINTOSH-HEMPHILL COMPANY · PITTSBURGH · U.S.A. ·

MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: all types of cast mill rolls . . . improved Johnston patented corrugated cinder pots and slag handling equipment . . . Mackintosh-Hemphill rotary straighteners—electronically controlled contouring lathes—screw feed roll turning lathes—heavy duty engine lathes . . . shears . . . end-thrust bearings . . . steel and special alloy castings . . . reversing hot strip mills . . . Y-type cold strip mills.

For *positive* bearing protection on Military Jeeps-

KLOZURE Garter Spring Model 65

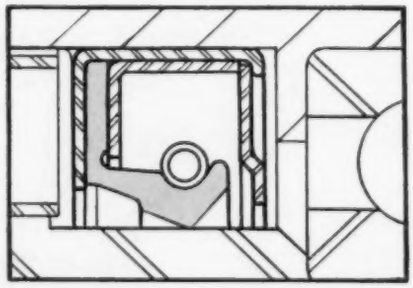
Every Willys Military Jeep has a "transfer case" which provides for 2 functions: (1) Engaging the front axle drive; (2) Engaging the emergency low gear ratio. Spicer uses dependable Garlock KLOZURES to protect the front and rear bearings on the output shaft of this important mechanism.

Spicer uses KLOZURE* Oil Seals

The Spicer "transfer case" in a Military Jeep must be able to function smoothly under the most adverse operating conditions. Thus, the bearings on the output shaft (which operates at speeds up to 4,000 R.P.M.) need *positive* protection against dust, mud, and water; the bearing lubricant must be sealed in. This job calls for a superior oil seal. Spicer engineers rely on KLOZURE garter-spring Model 65.

Take a tip from Spicer, who for 50 years has been manufacturing precision parts for the automotive industry. Standardize on KLOZURE Oil Seals—the best bearing protection money can buy.

There's a service-tested KLOZURE model for every bearing application. For complete information contact your Garlock representative or write for KLOZURE Catalog No. 10.



Installation of Model 65 KLOZURE Oil Seal on the output shaft bearing of the Spicer "transfer case."

*Registered Trademark

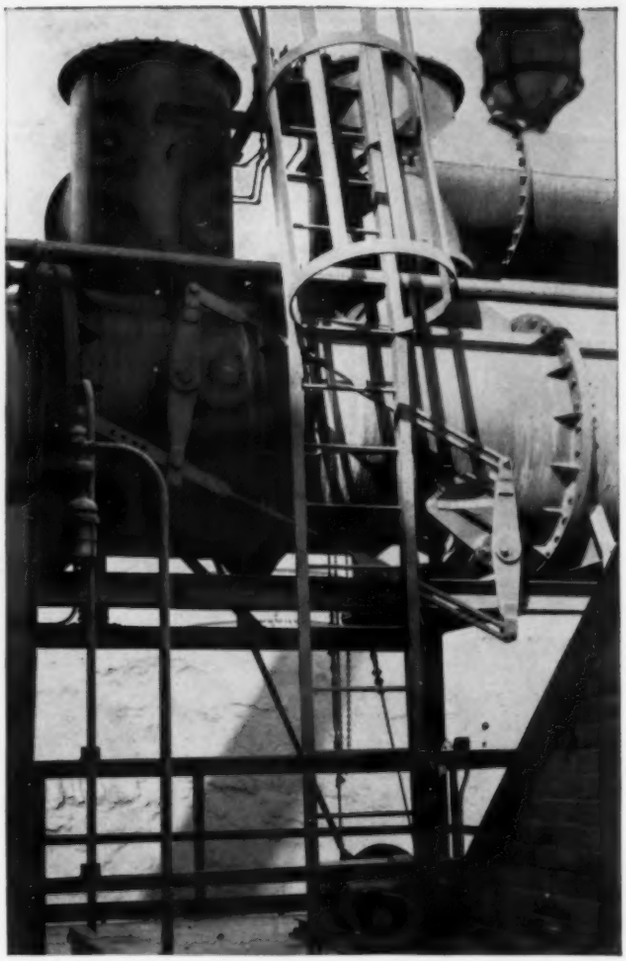
THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

Sales Offices and Warehouses: Baltimore • Birmingham • Boston • Buffalo • Chicago • Cincinnati • Cleveland • Denver • Detroit Houston • Los Angeles • New Orleans • New York City • Palmyra, (N.Y.) • Philadelphia • Pittsburgh • Portland (Ore.) • Salt Lake City • San Francisco • St. Louis • Seattle • Spokane • Tulsa.

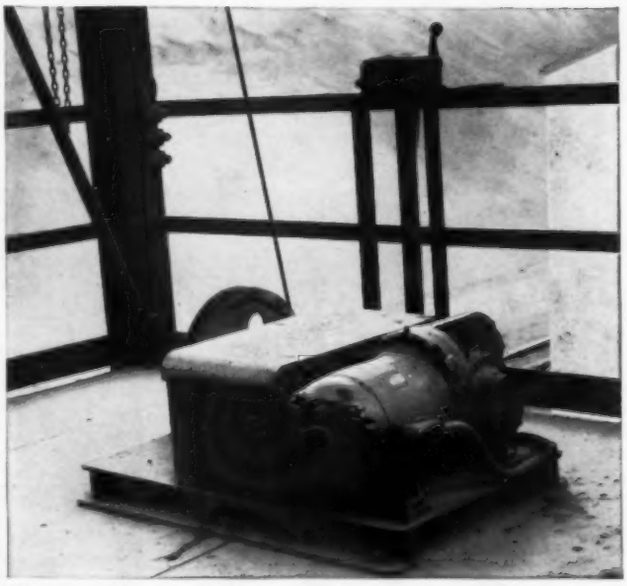
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

GARLOCK

PACKINGS, GASKETS, OIL SEALS
MECHANICAL SEALS
RUBBER EXPANSION JOINTS



The Complete Assembly



The Operator

Blast Furnace SNORT VALVE may now be MOTOR OPERATED

- The operator is adaptable to a variety of valve designs.
- Existing valves may be electrified.
- Mechanical operation of the valve is preserved intact.
- Electrical operation is the normal mode. In the event of power failure, reversion to manual operation is automatic.
- A small master switch supplants the hand wheel.
- Multiple stations for electrical operation are provided.
- Quicker response, easier control.

SUCCESSFUL OPERATION DEMONSTRATED

KOPPERS

KOPPERS COMPANY, INC.

Freyn Department

Engineering & Construction Division

KOPPERS BUILDING - PITTSBURGH 19 *Associated with* Ashmore, Benson Pease & Co. Ltd., Stockton-on-Tees, ENGLAND; De Loitre & Frouard, Paris, FRANCE

Choose from 11 types of

Ohio Iron and Steel Rolls:

- Carbon Steel Rolls
- Ohioloy Rolls
- Ohioloy "K" Rolls
- Ohio Double-Pour Rolls
- Holl-O-Cast Rolls
- Chilled Iron Rolls
- Denso Iron Rolls
- Nickel Grain Rolls
- Special Iron Rolls
- Nioloy Rolls
- Flintuff Rolls

Ohio Rolls

SHAPING METAL FOR ALL INDUSTRY

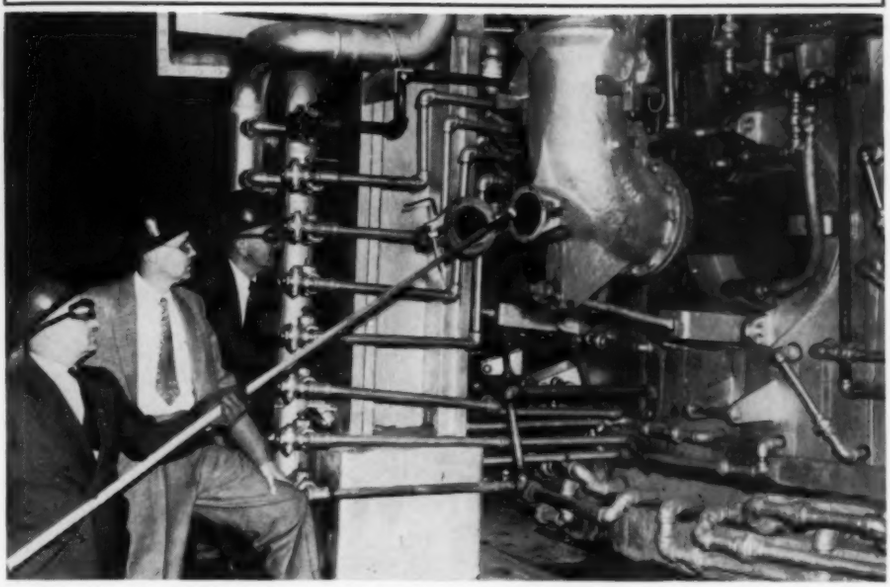
THE OHIO STEEL FOUNDRY CO.

LIMA, OHIO

Plants at Lima and Springfield, Ohio

Industry News...

NEW BLAST FURNACE PUT INTO OPERATION AT CLEVELAND BY AMERICAN STEEL & WIRE



Thrusting a lighted flare into new Blast Furnace "A" at American Steel & Wire's Central Furnaces and Docks Works, Bronislaw S. Klimczyk is watched by John E. Allen, general superintendent, and Harry L. Jenter (right), Cleveland district manager for this United States Steel Division.

▲ The newest addition to Cleveland's industrial skyline was put into operation, September 23, with American Steel & Wire's new blast furnace.

The new furnace, which has a capacity of 1350 tons of pig iron per day, will supply many foundries in northern Ohio, as well as in Michigan.

The new unit is one of the most modern and efficient in the area. The latest technological advances looking toward efficient production, have been included, and every effort has been made to make this the cleanest operation possible in eliminating air and stream pollution.

Equipment has been provided for the sludge removal system which cleanses the cooling water before returning it to the Cuyahoga River. In addition the modern designs in the dust catcher, gas washer, and electrostatic precipitators combine to assure the cleanest possible discharge to the atmosphere.

J & L CONVERTER BOTTOM PRODUCES 100 HEATS

▲ Another new length-of-service record is believed to have been set by a bessemer converter bottom at J&L's Aliquippa Works. A bottom on No. 3 converter produced 100 full heats of steel—a total of 2529 tons—before giving out after running for four minutes on the 101st heat. The previous J&L and industry record number of heats per bottom was 92. This record was set in June.

The same day the bottom on No. 3 set the new record, the bottom on No. 1 made its 80th heat, and the bottom on No. 2 its 64th. This gives an average of 81.66 heats for the three bottoms, a mark which is thought to be a record for three bottoms blowing at the same time.

J. N. Albaugh, superintendent of the Open Hearth & Bessemer Department at the Aliquippa Works, says that the 100-heat record is by far the best mark record ever made by a bessemer bottom, as nearly as he can determine from industry records. He thinks the record is "safe for a long time." But he and his crews will keep on trying to bring up the average number of heats blown per bottom.

ARMCO OPERATES NEW ANNEALING FACILITIES

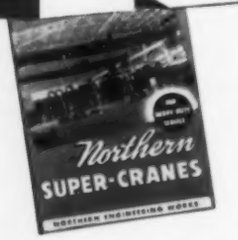
▲ Now in operation at Armco Steel Corp.'s East Works plant at Middletown, Ohio, is one of the newest and most modern annealing departments in the steel industry.

Armco has just added twelve new coil annealing furnaces to its present capacity. Together with a new building to house them, the furnaces represent an investment of $1,750,000.

TRADING BEGINS AT CHICAGO ON SCRAP FUTURES

The scrap iron and steel started trading on futures contract on the Chicago Mercantile Exchange, on September 7. Such trading should reduce price variations on scrap.

NORTHERN SUPER CRANES • UP TO 150 TONS



Northern Super Cranes—since 1899—have been moving endless tonnages of material in thousands of plants in the United States and other countries. For safety, durability, precise manipulation, unsurpassed electrical equipment, minimum maintenance and maximum dependability in heavy duty service, many plant managers have installed Northern Cranes exclusively.

Write for Bulletins SE-108-A and G-700

NORTHERN HI-LIFT CRANES • UP TO 20 TONS

Northern Hi-Lift Cranes are intended both to supplement Northern Super Cranes in heavy duty service and to provide economical work handling in lighter service. They have the same engineering features as Northern Super Cranes —low design stress for safety—high grade steels, turned and ground shafts and press fits for durability—highest quality electrical equipment and controls for dependable operation.

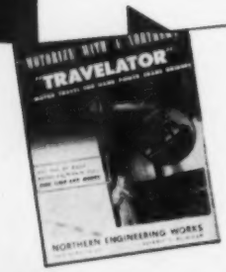
Write for Bulletin HL-115-R

NORTHERN HI-LIFT HOISTS • 2 TO 15 TONS

Northern Hi-Lift Hoists are heavy duty type electric hoists, designed especially for low headroom installations. They feature heavy duty roller bearings, extra heavy bearing shafts accurately press fitted with bearing races, extra large independent mechanical and electric brakes, and many other elements required in a good investment in hoist equipment.

Write for Bulletin H-112

NORTHERN TRAVELATORS • FOR LIGHT CRANES



The Northern Travelator is a bridge drive unit which can be applied to a hand traveled crane to convert it to power travel. It can be easily installed by your own mechanics and electricians in a few hours time. The roller chain drive facilitates installation and provides longer life and greater ability to absorb the usual impacts of crane service.

Write for Bulletin T-105

NORTHERN CRANES—HOISTS—TRAVELATORS

NORTHERN ENGINEERING WORKS
210 CHENE ST., DETROIT 7, MICH.

These new facilities are part of the "balancing out" program that Armco has had underway here since the construction of three new open hearth furnaces and a blast furnace increased the steel capacity of the plant.

The new furnaces are especially designed to provide the carefully controlled heat treating that is a requirement of modern high grade sheet steel.

They are of the single-stack, convector type, and will anneal 75 tons of coiled steel per charge. The twelve furnaces will operate on thirty-six bases, thus allowing ample time for preparing new charges and controlled cooling. Monthly capacity of the new department is 12,500 tons.

The furnaces will burn coke oven gas from Armco's ovens here and at Hamilton, Ohio. Controls are housed in a special air-conditioned room, where constant temperatures and humidity will insure precise functioning of the instruments.

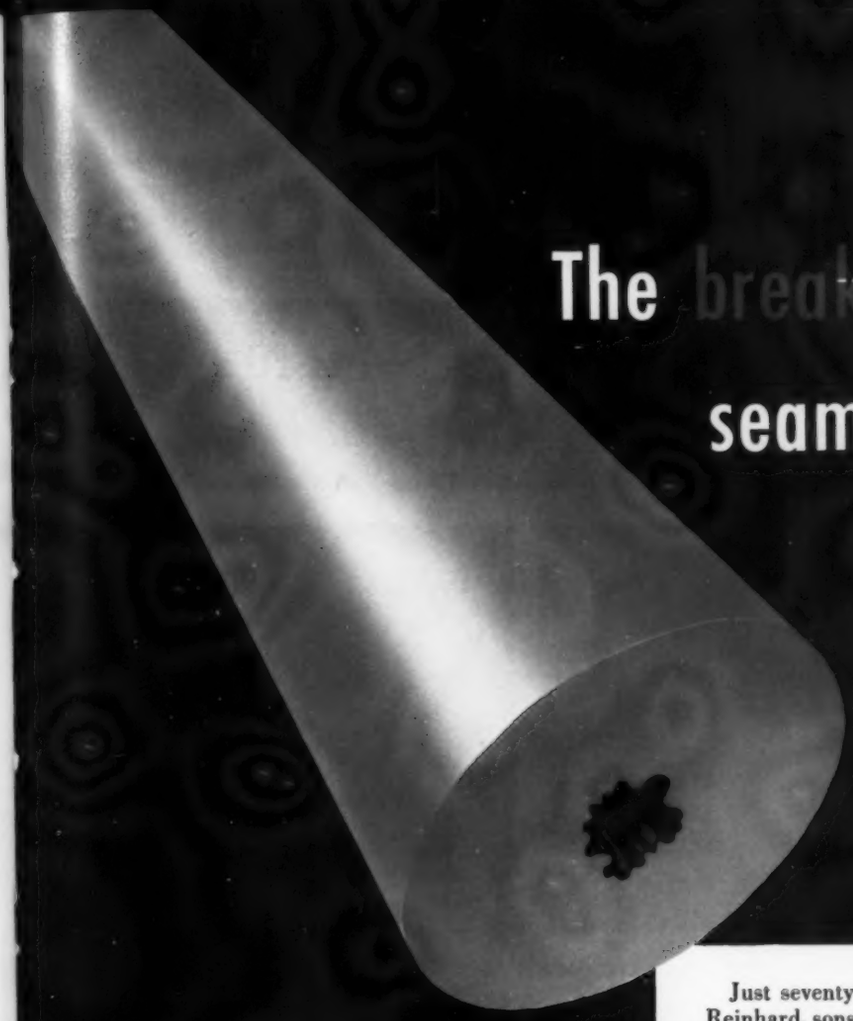
The new building has a unique air cooling installation. Large fans bring in outside air which is first filtered, then blown upward through trenches in the floor and finally allowed to escape at the top of the building. The system provides comfortable working conditions and permits the fans in the furnace bases to operate under extremely high temperatures.

Next to the furnace building another new building provides cooling space and storage area for annealed coils.

NEW COKE BATTERY SCHEDULED FOR LORAIN

▲Another new battery of coke ovens will be constructed at Lorain Works, National Tube Division, U. S. Steel Corp. This will be the fifth new battery installed at Lorain since the plant was modernized in 1947 and will be designated as Battery H. Contract for the new battery has been awarded to Koppers Company, Inc., Pittsburgh, Pa., and will consist of 59 Koppers-Becker gun flue type ovens.

Included among the coal handling and chemical recovery auxiliaries to be installed will be a coal bin, a flushing liquor decanter and a primary cooler. When placed in operation in about a year, the new battery will carbonize nearly 1100 tons of coal a day.



The break that gave seamless tubing its start

Just seventy years ago the Mannesmann brothers, Max and Reinhard, sons of a German file manufacturer, found themselves creating the world's first seamless tube rolling mill.

They'd been investigating the development of centralized holes in steel bars that had been rounded and polished on a skewed-roll reeling machine. Experiment showed that the faults were caused by the reeling.

Suddenly it occurred to them that the same rolling technique could be carried to an extreme to produce a hollow tube. How important was this discovery? Well, today in nine out of ten seamless mills around the world, you'll find a Mannesmann piercing mill. This modern version of the original Mannesmann brothers' mill utilizes the rotary squeezing action of two skewed rolls to force a hot steel billet over a mandrel point at the incredible rate of over 150 fpm.

Putting this skewed-roll principle to work in turning out seamless tubing is only one of the many "firsts" linked with this famous German firm. Now the American company, Mannesmann-Meer, brings to U.S. metal producers the advantages of Mannesmann experience in seamless tube mill design and operation plus the unique engineering know-how of Meer, the famous German steel mill machinery manufacturer.

Nowhere in the world will you find an organization more experienced and better equipped to handle your pipe and tube mill problems than Mannesmann-Meer. *Mannesmann-Meer Engineering and Construction Co., 900 Line Street, Easton, Pa.*

M.4.1

MANNESMANN-MEER

World Specialists in High-Speed Tube Mill Machinery

Reduce Steel Mill Fire Hazards...*

with HOUGHTO-SAFE HYDRAULIC FLUID

Hydraulic applications near heat such as dolomite chargers and coke oven door closers call for Houghto-Safe non-flammable hydraulic fluid.

Houghton Houghto-Safe is not "just another non-flammable fluid". It is a fluid developed expressly to meet *all* the demands of efficient operation of hydraulic equipment.

First, it will not burn! It is a "snuffer" type, water-base fluid that will put out fires—not start them!

Second, it incorporates the lubricating qualities and high film strength necessary to assure normal pump and equipment life.

Third, it will not affect standard packing materials. Whatever packings you are now using will function equally well with Houghto-Safe.

Fourth, it is non-toxic. There are no fumes given off by Houghto-Safe and it has no ill effect upon actual contact with the skin.

In fact, Houghto-Safe gives you *all* the operating benefits of standard hydraulic oils and—IT WON'T BURN!

Don't take chances with plant, equipment, personnel or production. Investigate Houghton Houghto-Safe for every hydraulic application operating near flame or high heat.

E. F. HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

HYDRAULIC FLUIDS and PACKINGS, LUBRICANTS, COOLANTS and CUTTING OILS, RUST PREVENTIVES

Battery I, which has been under construction since May, 1953, is approximately 95 per cent completed. Battery I is another group of 59 gun flue type ovens. It is expected that sometime in the future the four older coke batteries, which have operated continuously at Lorain Works since 1918, will be retired.

COLD MILL BEGINS 24-HOUR OPERATION

▲ Pittsburgh Steel Co.'s new cold rolled sheet mill has started round-the-clock operations for the first time since it began production in April, the company reported today.

A third shift has begun operating the new four-stand 66-in. tandem cold reduction mill at Allenport, operated previously by two shifts only. Other operations throughout the mill will be stepped up to process the additional output of cold rolled sheet.

A substantial increase in the volume of orders is responsible for the rising level of operations. Start of round-the-clock operations signals successful completion of the proving-in period.

Production was also resumed on No. 2 blast furnace at Monessen.

TO BUILD TITANIUM PLANT AT ASHTABULA

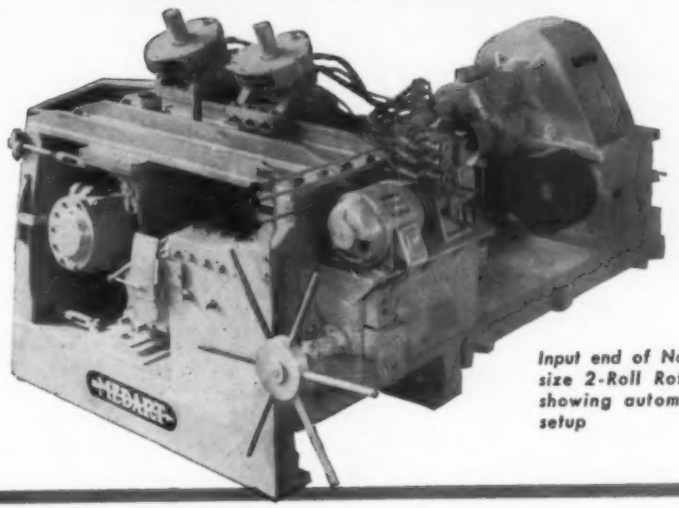
▲ Plans for production of at least 7500 tons of titanium metal a year, at a new plant costing approximately $31,500,000, were announced by A. L. Foscue, president of Electro Metallurgical Co., a Division of Union Carbide and Carbon Corp., following the signing of a contract with the Government. Under the terms of the contract, the General Services Administration has agreed to purchase from Union Carbide, for a five-year period at prevailing market prices, that part of the plant's output not sold to private industry.

This will be the first commercial production of titanium by a method other than the Kroll process. The Electromet process involves sodium reduction of titanium tetrachloride, which produces metal of exceptional quality. The Company has had this process in operation on a pilot and prototype plant scale at its Metals Research Laboratories in Niagara Falls, New York. The commercial plant, which is expected to take

Now! Automatic Set-Up Of Precision Bar Straightener!

MEDART

2-ROLL ROTARY STRAIGHTENER SIZER & POLISHER



Input end of No. 3 size 2-Roll Rotary showing automatic setup

- Full automatic adjustment of straight roll
- Full automatic adjustment of concave roll
- Full automatic adjustment of bending pressure and roll opening for bar sizes
- New style large numbered scales for roll angles plus new scale for bar size
- Precision straightens, sizes and polishes, and corrects out-of-roundness, from end to end, on any round ferrous or non-ferrous workpiece, solid or tubular
- Puts a super finish (10 micro-inch or better) on cold-drawn, turned and ground stock
- Removes mill scale from hot-rolled surfaces
- Improves the physical properties of the workpiece
- End-to-end feeding, with 2-direction operation, gives continuous uninterrupted sizing and polishing at high throughput speeds

Write For Complete Catalog!

THE MEDART COMPANY 3535 DE KALB STREET ST. LOUIS 18, MO.

On Again...Off Again

Ground Lamps Indicating Trouble?

Eliminate grounds and short circuits by installing Adalet insulating bushings on every conduit terminal. Underwriters Laboratories approved, strong but resilient, they are used extensively by steel mills, chemical plants, etc. to assure:

1—Trouble-free wiring

2—Adequate protection

3—Minimum maintenance

SALI insulating bushings are available for rigid or thin-wall conduit, threaded or threadless. Male or female types or precision molded bushings are also available.

Request Bulletin A or ask for complete Adalet Catalog

THE ADALET MANUFACTURING CO.

CLEVELAND 11, OHIO

about a year and a half to get into production, will be built at Ashtabula, Ohio.

IMPROVE STRUCTURAL MILL AT HOMESTEAD

▲ Major improvements in the finishing facilities for Structural shapes at Homestead District Works will follow completion of detail engineering plans now underway, it was announced recently. The improvements will be designed to meet the increased demand for light wide-flange structural sections for which the mill has limited capacity.

When originally built, the Homestead structural mill was designed to produce a large percentage of heavy wide-flange beams. However, in recent years the percentage of lighter weight beams has been growing steadily, and the present finishing facilities will be improved to take care of this demand.

Work will commence on the new improvements as soon as engineering plans have been completed. Similar improvements are planned for the structural mill at the company's South Works in Chicago.

OAKITE OPENS NEW RESEARCH LABORATORY

▲ Research and product development in chemical cleaning took another step on September 15, when Oakite Products, Inc., threw open the doors to their new and expanded laboratories at 350 Hudson Street, New York City.

The laboratory, which is sub-divided into three major sections—product development, customer service, and engineering—will devote itself to the cleaning and sanitation problems of the nation's production and service industries. In addition, a complete pilot plant is planned for the small scale manufacture of detergents and solvents prior to extensive field testing.

The chemical research laboratory, manned by a staff of chemists and chemical engineers, working in 11 special laboratories, spearheads all new product developments.

Each laboratory is set up with completely modern equipment to aid in the study of various soils and the effect different cleaners have on them.

The new laboratories, while equipped to handle any problem industry might presently have, would eventually go on to even greater internal expansion to match the increasing complexities that crop up in industrial cleaning.

ACQUIRES INVENTORIES OF THE TORCON CORP.

▲ Clark Equipment Co., a leading supplier of automotive components, industrial materials handling trucks and construction equipment, announced recently the acquisition of inventories, engineering designs and products, tooling, trademarks and patents and certain other assets of The Torcon Corp., Ashtabula, Ohio, a producer of torque converters.

The transaction will enable Clark Equipment Co. to offer the broadest line of torque converters and transmissions available from any single source. Principal customers for this type product include manufacturers of automotive and construction equipment and equipment used for oil field and logging applications.

In taking over inventories and business-in-hand of Torcon, Clark Equipment Co. is not purchasing Torcon's capital stock nor is Clark assuming its liabilities, according to C. H. King, Clark vice-president. Clark also is not acquiring Torcon's plant facilities at Ashtabula, nor its basic machine tools.

Production operations for the manufacture of the torque converters will be transferred to Clark's transmission plant at Jackson, Mich., under the supervision of Roy McDermott, manager of the transmission division. A number of key personnel from the Torcon organization have joined Clark to continue their activity in this field.

BEGINS PRODUCTION OF ELECTROLYTIC COBALT

▲ As a result of improvements in refining techniques, The International Nickel Co. of Canada, Limited, has initiated production of electrolytic cobalt at its Port Colborne refinery, Ralph D. Parker, General Manager of Canadian Operations and Assistant Vice-President of the company, announced on October 1. This marks the first commercial production of electrolytic cobalt in Canada.

Big and "little" friends: 26,000 and 10,000 lb. trucks

Save more money by handling bigger loads

—with the world's largest standard lift truck—26,000 lbs.

The Clark-Ross Y-260 will handle bigger outdoor loads than any other lift truck, and it will go places where no other lift truck can travel! This truck is big enough to handle jobs which formerly required a crane and operator, hook man and trucker. It has the utmost traction and flotation—huge 14.00 x 20 tires are standard front and rear, with excellent weight distribution and 9 in. minimum underclearance. Its 17½ ft. turning radius permits it to be used in yards laid out for smaller trucks.

This Y-260 is *built* for 26,000 lbs. (at 36 inches)—not just beefed-up. It's as easy to drive as a truck half its size; power steering and power brakes are standard. And a brake selection switch enables the driver to apply brakes to *either* drive wheel, when one wheel has lost traction in slippery grounds. Maintenance access is excellent, wrap-around counterweight has minimum over-hang, operator visibility is outstanding. In general, *this lift truck is a beautiful brute!*

For big jobs, you'll want more details on the Y-260. Call your local Clark dealer, listed in the Yellow Pages under "Trucks, Industrial," or send the coupon.

CLARK EQUIPMENT

Industrial Truck Division
Battle Creek 135, Michigan

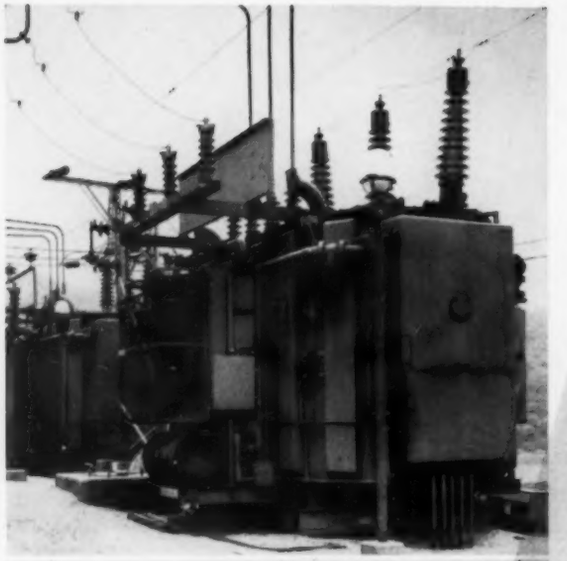
Send details on Y-260

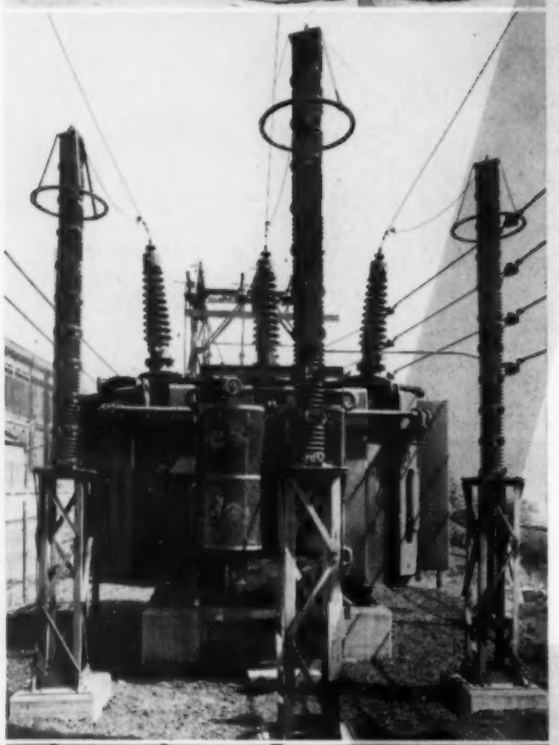
Name_____

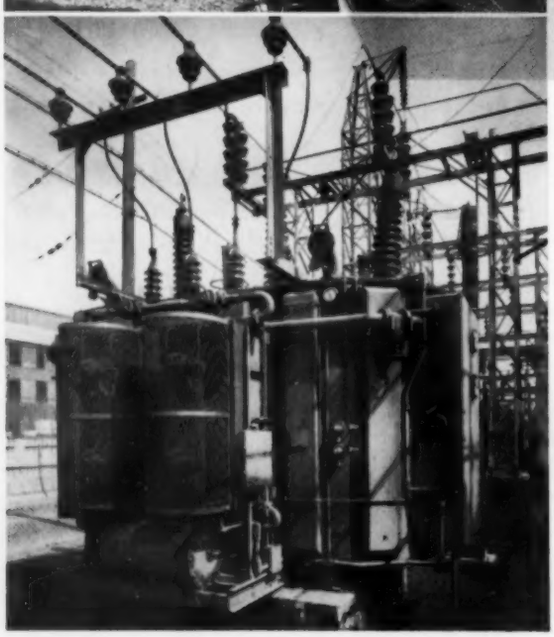
Firm_____

Address_____

City_____







...Four 30,000 kva PENNSYLVANIA TRANSFORMERS

supply the power requirements of the Brackenridge plant of ALLEGHENY LUDLUM STEEL CORPORATION

Each of these transformers is rated at 30,000 Kva, 3 Phase, Oil-Immersed, Forced-Oil-Cooled. Together, the four transformers supply 120,000 Kva of power to the Brackenridge Plant. But as usual, there is more to the story than the rating of the transformers.

Here are four transformers that were designed to rigid height limitations so they could be delivered by trailer truck to their installation sites. The voltage — 132 Kv — called for intricate engineering and strict attention to mechanical detail.

The first unit to be installed at Brackenridge illustrates how carefully the design was worked out. The transformer was trucked over 44 miles of first and second class highway and rolled off the trailer onto its foundation — all in one day. To reach Brackenridge, each transformer had to be light enough to go over bridges, small enough to go under viaducts, and properly distributed in weight to negotiate sharp curves with safety.

For a better picture of how this was done, we invite you to write us on your letterhead to arrange for a showing of our 16mm. black and white movie entitled "30,000 Kva En Route."

Pennsylvania Transformer Company

A McGraw Electric Company Division • **Canonsburg, Pa.**

GREATER PITTSBURGH DISTRICT

AIRCRAFT SKIN

This section of integrally stiffened aircraft skin is the widest aluminum shape ever extruded flat. It was produced at the Lafayette, Ind. works of Aluminum Co. of America. The press, which can apply 14,000 tons to force aluminum through its dies, extruded the 23-in. wide section in 75S alloy.

Heretofore Inco's entire cobalt output has been marketed as oxides and salts produced at its Clydach, Wales, refinery. Through its new process the company makes available a high purity cobalt which is a fitting companion to its electrolytic nickel. This electrolytic cobalt will be particularly valuable in the manufacture of alloys where high purity is advantageous.

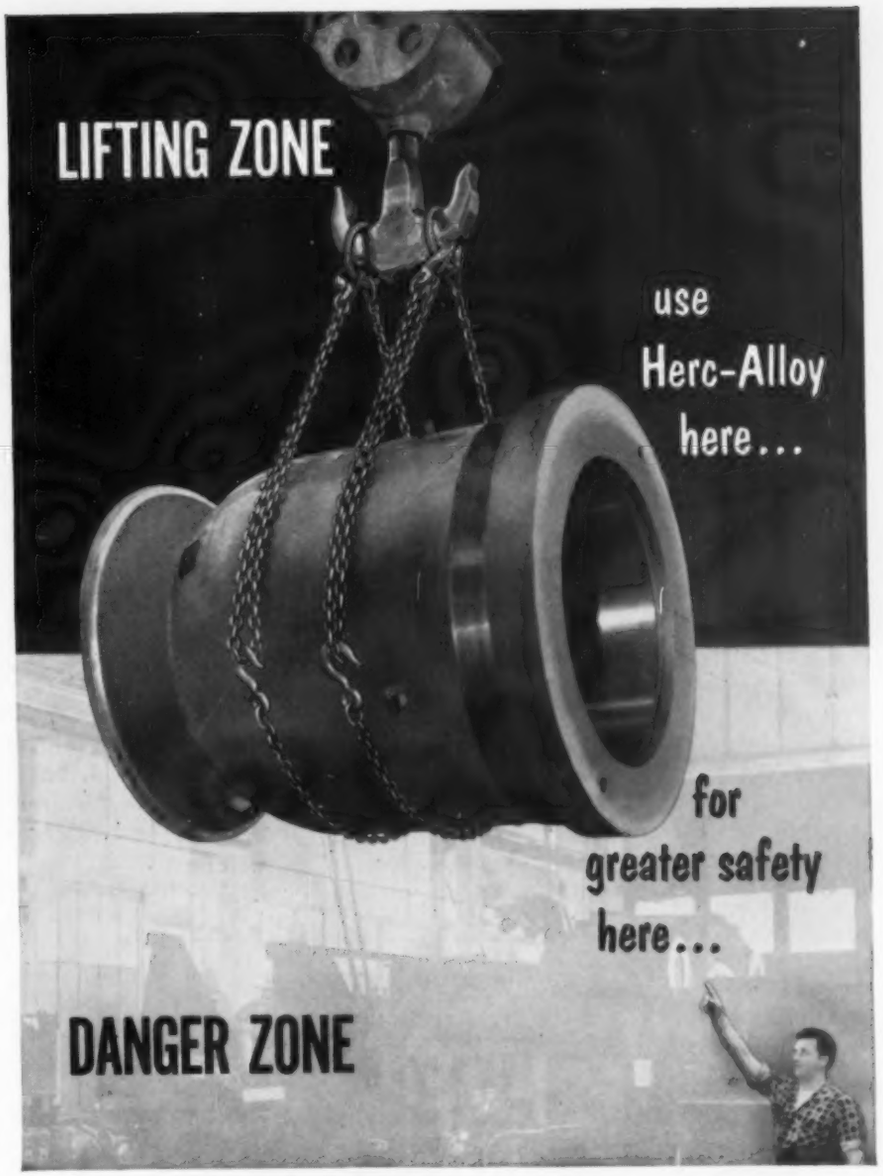
JOHNS-MANVILLE OPENS CANADIAN ASBESTOS MILL

▲Johns-Manville opened the largest asbestos mill in the world at Asbestos, Quebec on September 30. It will mill more than one-third of the free world's supply of asbestos fibre most of which finds its way to the United States.

The new Johns-Manville mill will replace several existing mills and provide more modern facilities with increased production capacity at lower operating costs. The new mill is the latest project of the Quebec asbestos mining industry which has embarked upon a $70,000,000 program of expansion and development of new mines, mills and machinery.

DRAVO CORP. ENTERS ORE SINTERING FIELD

▲ Dravo Corp., Machinery Division, Pittsburgh, Pa., announces the addition of iron ore sintering and pelletizing equipment to its line of industrial machinery. Under an exclusive licensing agreement with Lurgi Gesellschaft fur Chemie und Huttenwesen, M. B. H., Frankfurt, A. M., Germany, Dravo will manufacture



SPECIFY
HERC-ALLOY
SLING CHAINS

Write for Data Book

HERC-ALLOY
Sling Chains are made-up to order, are individually tested, registered and guaranteed.

Hundreds of plants like the one shown above* are using Herc-Alloy Sling Chains. Greater safety is their big reason for doing it. But there are other factors too. Herc-Alloy is economical because of its long service life. Then too, the use of alloy steel permits a weight reduction that helps prevent worker fatigue. These advantages are worth thinking about. Those who do consider them seriously generally adopt safe Herc-Alloy Sling Chains for their plants.

*LAKE ERIE ENGINEERING CORPORATION — MANUFACTURER OF HYDRAULIC PRESSES

CM HOISTS AND CHAIN

COLUMBUS McKINNON
CHAIN CORPORATION
TONAWANDA, NEW YORK
DISTRICT OFFICES: NEW YORK, CHICAGO, CLEVELAND
In Canada: McKINNON COLUMBUS CHAIN LIMITED, ST. CATHARINES, ONTARIO

and market complete iron ore sintering and pelletizing plants for the ore and steel industries in the United States.

The Dravo-Lurgi machinery will be an adaptation of the Lurgi Chemie basic design in accordance with American standards so as to assure reliable domestic service and quick delivery of equipment and parts. The association of these two internationally known organizations makes available to the steel industry Lurgi's experience of 40 years in sintering iron and non-ferrous ores backed by the more than 60 years manufacturing and engineering-construction experiences of Dravo.

Lurgi Chemie is Europe's oldest and foremost designer of ore sintering machinery. Its pilot plants and laboratories are equipped to handle and process any type of ore sample. Its down-draft sintering process has gained wide European acceptance since first introduced in 1906 and, at the present time, Lurgi machines process 90 per cent of the ore sintered in Germany. Yearly output of Lurgi Chemie installations treating iron ore alone totals over 30,000,000 tons.

Dravo Corp., also announced receipt of a contract to furnish Dravo-Lurgi iron ore pelletizing equipment for the Copper Cliff, Ontario, plant of the International Nickel Company of Canada. The pellets will be hardened on a continuous, straight-line sintering machine.

The new machine 8-ft 3-in. wide and one of the largest iron ore sintering machines ever built in this country, will be manufactured by Dravo in accordance with the basic designs of Lurgi Gesellschaft fur Chemie und Huttenwesen M. B. M., Frankfurt A. M., Germany.

CONTINENTAL FOUNDRY ACQUIRES MEDART LINE

▲ To supplement its line of steel machinery equipment, Continental Foundry and Machine Co. has acquired the Bar and Tube Machinery line of the Medart Co., St. Louis, Mo.

The Medart Co. has for the past 75 years supplied this equipment for the cold finishing of steel and nonferrous products. For many years, Medart straighteners have set the standards for the industry.

In addition to straightening equipment, Medart has pioneered developments in centerless turning and billet peeling. Continental plans continuing research and development of this cold finishing equipment to widen the application of its products in the industrial field.

The engineering and sales offices for the Medart products will be located in the Continental Building in Pittsburgh, Pa.

Patterns and manufacturing machinery are being transferred to Wheeling, W. Va., where Continental will build the bar and tube machinery in the future.

G-E OPENS WELDING PLANT AT YORK, PA.

▲ The official opening of General Electric Co.'s welding plant of York, Pa. was held Thursday, October 21.

The result of long-term planning, the plant is headquarters of G-E welding products and contains manufacturing facilities that make it one of the most modern organizations of its kind in industry.

Formerly located at Fitchburg, Mass., the welding department moved its entire manufacturing and administrative facilities to York last January.

The plant, consisting of a group of modernized and rehabilitated structures, will be utilized to manufacture a-c transformer, d-c rectifier, d-c motor-generator and d-c engine welders.

ANNOUNCES CHANGE OF COMPANY NAME

▲ The Cooper Alloy Foundry Co., Hillside, N. J., announced on September 9 that in view of continued extension of facilities and services, the name of the company has been changed to Cooper Alloy Corp. Harry A. Cooper, company president, explained that Cooper Alloy is one of the nation's oldest and largest producers of stainless steel cast products, but that for many years has been manufacturing special product lines in addition to producing custom castings.

ENTERPRISE
78 In. Crank Pin
TURNING
MACHINE
Also Available
In 36 Inch Size
• HERRINGBONE GEARS
• POWER DRIVEN STEADY REST
• TWO INDEPENDENT TOOL CARRIAGES
• 3—"V" LONG WEARING WAYS
• HEAVY 4-WALL CAST IRON BED
Completely turns the pins, cheeks and heels of the crankshaft. Designed primarily as a roughing machine but may be used for finish turning also.
For complete information write for Bulletin 302
ESTABLISHED 1870
THE ENTERPRISE COMPANY
MACHINERY BUILDERS & ENGINEERS
SUBSIDIARY OF WM. K. STAMETS COMPANY · PITTSBURGH
COLUMBIANA 1, OHIO · U. S. A.

ANNOUNCE FORMATION OF CONSULTANT FIRM

▲ Announcement is made of the formation of the Baldwin-Gregory Co., located at 121 Kemp Avenue, Fair Haven, N. J. as consultants on hot dip galvanizing problems.

The company will specialize in the surveying of existing plants or departments and recommending of improvements. It will layout, plan and supervise the installation of new plants or rearrangement of present ones, including assisting in securing of equipment, designing of special equipment and training of operating personnel.

The new company will bring to bear over twenty-five years of experience in the practice and theory of hot dip galvanizing in its top executives, Allen T. Baldwin and William P. Gregory. Mr. Baldwin is manager of Flux Sales with Hanson-Van Winkle-Manning Co., at Matawn, N. J. and Mr. Gregory is vice president of New Jersey Galvanizing and Tinning Works, Inc. at Newark, N. J. Both men will retain those positions in addition to functioning as executives at the Baldwin-Gregory Co.

BUILD CONTROLS PLANT AT MILFORD, CONN.

▲ Ground was broken at Milford, Conn. on September 15 for a new $2,000,000 pant of the Bridgeport Thermostat Division of Robertshaw-Fulton Controls Co. Located six miles from the heart of downtown Bridgeport, the modern one-story plant will be nearly double the size of the present plant.

BLAST FURNACE PARTS DOCK AT GREAT LAKES

▲ A series of blast furnace transportation problems ended at Zug Island on September 2 when cranes lifted a 70 ton cargo from the hold of the freighter, ADRIAN ISELAN, and deposited it on the dock of the Great Lakes Steel Corp., Detroit division of National Steel Corp.

The cargo consisted of two big parts for a blast furnace being rebuilt and enlarged for Great Lakes Steel by Koppers Co., Inc., of Pittsburgh. The rebuilt furnace is scheduled to be "blown in" next summer.

The two parts, each a steel casting weighing approximately 35 tons, are the bell and hopper for the furnace. Casting of the hopper in one piece rather than the customary four sections was regarded as a technical feat. The hopper is as wide as three passenger autos, and the bell is only slightly smaller.

ANNOUNCE ACQUISITION OF CHICAGO FIRM

▲ Pressed Steel Car Co., Inc., which in the past five years has become one of the nation's most widely and carefully diversified industrial concerns, has completed negotiations for its largest and most important acquisition so far. This acquisition is the Clearing Machine Corp. of Chicago, the country's leading manufacturer of mechanical and hydraulic presses for the metalforming industry.

Future Meetings

▲ The 10th Annual meeting and Lubrication Exhibit of the American Society of Lubrication Engineers, will be held in Chicago, Ill., at the Hotel Sherman, April 13, 14 and 15, 1955.

Forty-one papers have already been tentatively scheduled in 16 sessions. Five of these sessions will be devoted exclusively to a special short course in lubrication engineering during the meeting.

▲ Steel Founders' Society of America announced its annual Technical & Operating Conference on November

For every type of shearing machine and every kind of job
"multicut"
SHEAR BLADES and ROTARY KNIVES
Rx Engineered to the job . . . Every Wapakoneta blade is made to exact specifications, designed for the particular job. Complete records with order number of each blade makes possible duplication of exact size and temper at any time.
"MULTICUT", "TUFCUT", "HOT WORK"
THE WAPAKONETA MACHINE CO.
WAPAKONETA, OHIO.
Knives Engineered for the Job Since 1891

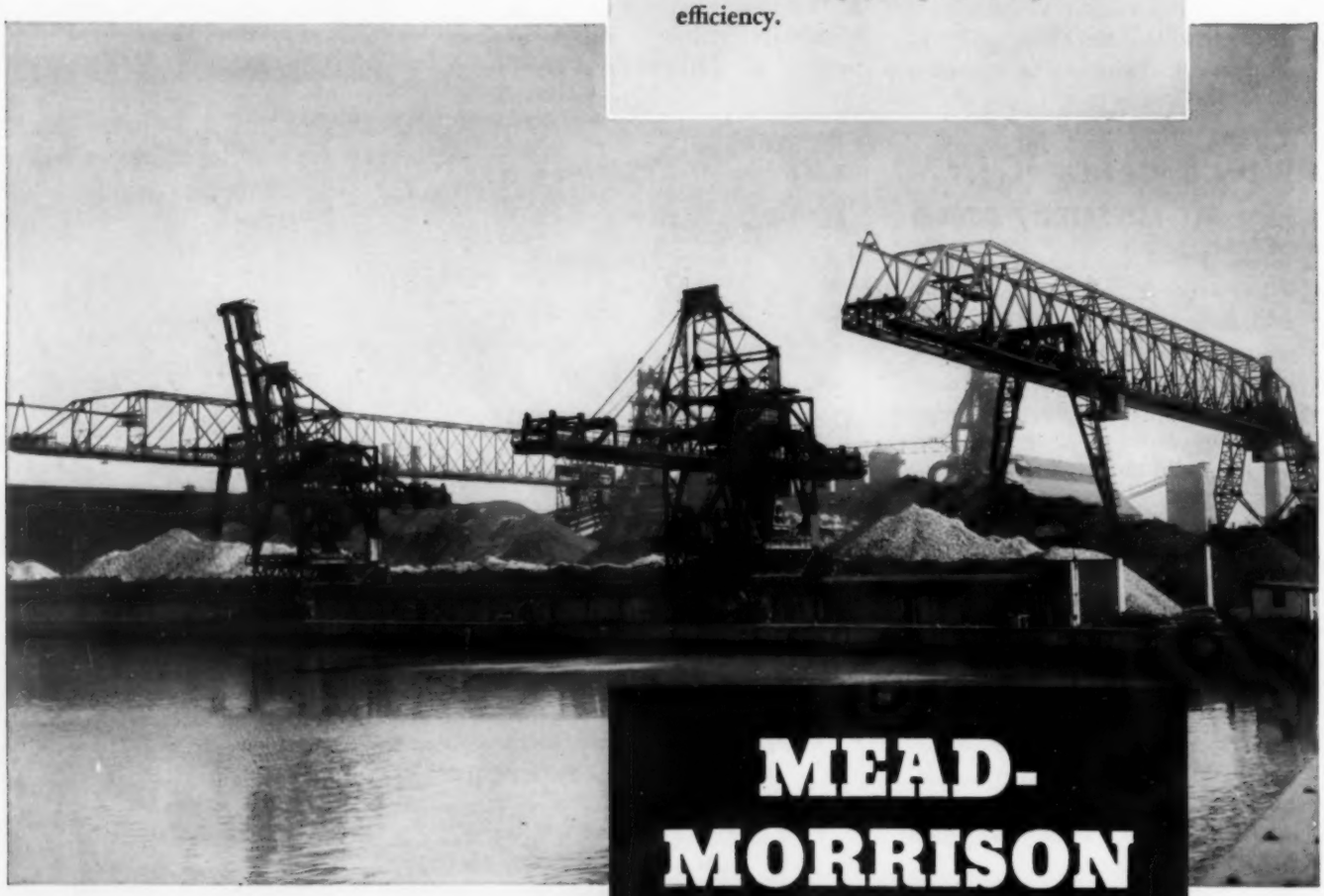
all set for speedy material handling

This team of two Unloaders and two Bridges are part of the Mead-Morrison material-handling equipment at a large midwestern steel mill.

Each of the structures and their equipment has a capacity of 12 tons and is of the man-trolley type. The unloaders discharge ore or limestone from lake steamers, and deposit it in the trough, from which it is rehandled by the bridges to storage piles and to the high line feeding the blast furnaces.

Additional Mead-Morrison Bridges and Unloaders are also operating in the coal storage yard of this same steel company.

If you need new unloading facilities or increased capacity from your present equipment, the Mead-Morrison engineers will help you plan for greatest efficiency.



MEAD-MORRISON

DIVISION OF McKIERNAN-TERRY CORPORATION · MANUFACTURING ENGINEERS · HARRISON, N. J.

MK808

3, 4 and 5 at the Carter Hotel, Cleveland, Ohio. It also announced its annual meeting for March 14 and 15, 1955 at the Drake Hotel, Chicago, Ill.

▲ The Gray Iron Founder's Society, Inc. will hold its 26th Annual Meeting at The Homestead, Hot Springs, Va. on November 11-12 1954, preceded by the President's Reception and Dinner on November 10.

▲ The Semi-Annual Technical Conference of the National Air Pollution Control Association scheduled for November 4, 5 and 6 in Los Angeles will feature practical aspects of efficiency and cost, along with specific details on installations of many types of air pollution control devices.

Industry-wide reports on control of air contaminants, using existing installations as illustrations, have been programmed.

▲ The 3rd National Air Pollution Symposium will be held April 18-19, 1955, at the Huntington-Sheraton Hotel, Pasadena, Calif.

Sponsoring the conference is Stanford Research Institute. Co-sponsors are California Institute of Technology, University of Southern California, University of California at Los Angeles, Southern California Air Pollution Foundation—all of Los Angeles—and the Air Pollution Control Association, Pittsburgh, Pa.

▲ The Tenth Annual Meeting of The Magnesium Association, will be held at the Hotel Chase, St. Louis, November 15, 16 and 17, 1954. This three-day session will be devoted to discussions of Magnesium In Use.

▲ The next Plant Maintenance & Engineering Show will be held at the International Amphitheatre, Chicago, Ill., January 24 to 27, 1955.

The show, staged for the sixth time, will be the largest in its history. It is now one of the largest industrial expositions in the country.

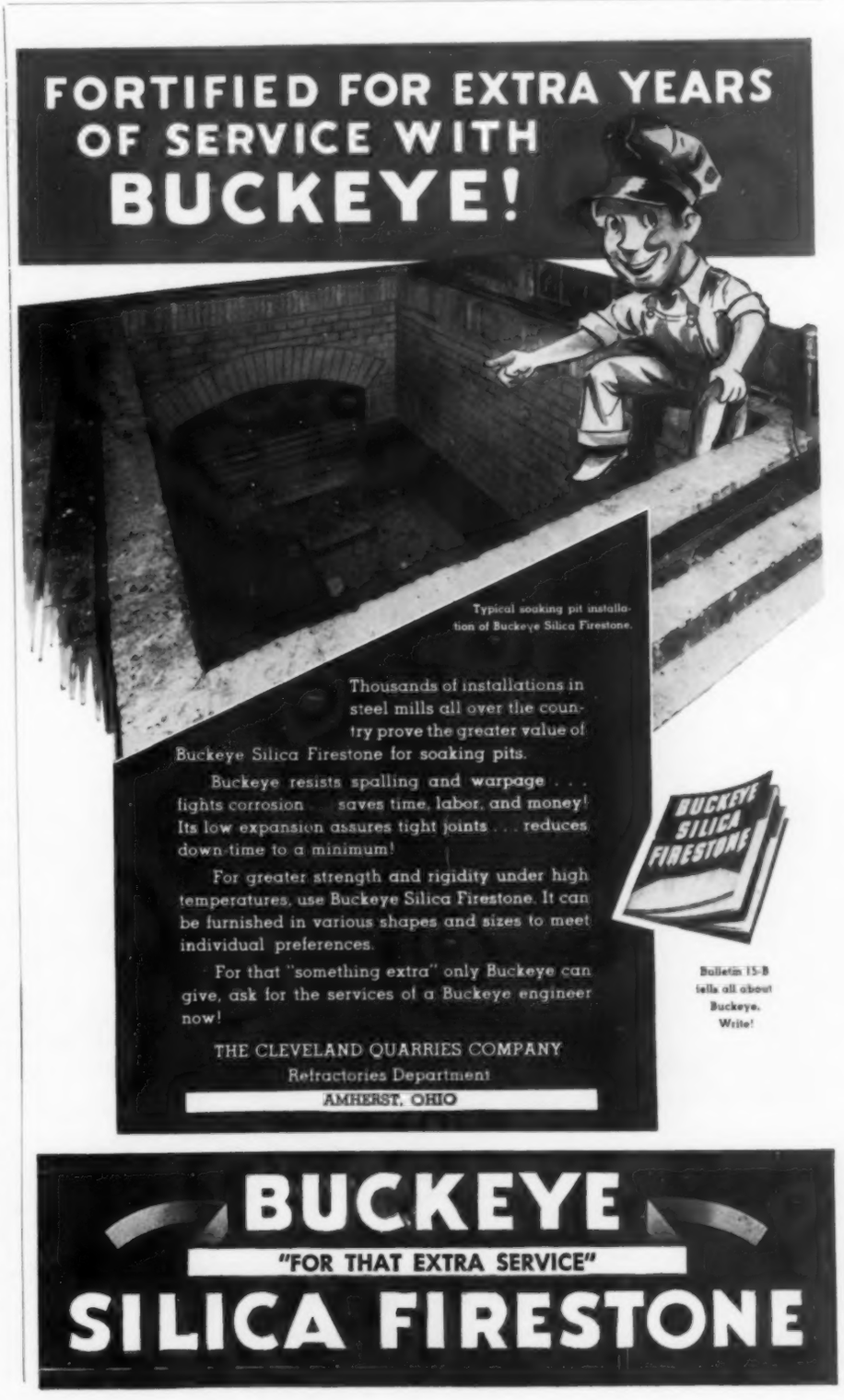
The show will be the first industrial exposition to occupy the huge new $2,000,000 hall which has been built as an addition to the International Amphitheatre. The new hall has 188,000 square feet of space, with large exhibit bays of 2,400 sq ft unobstructed by columns. Headroom is at least 20 ft in all parts of the hall and 26 ft in some areas.

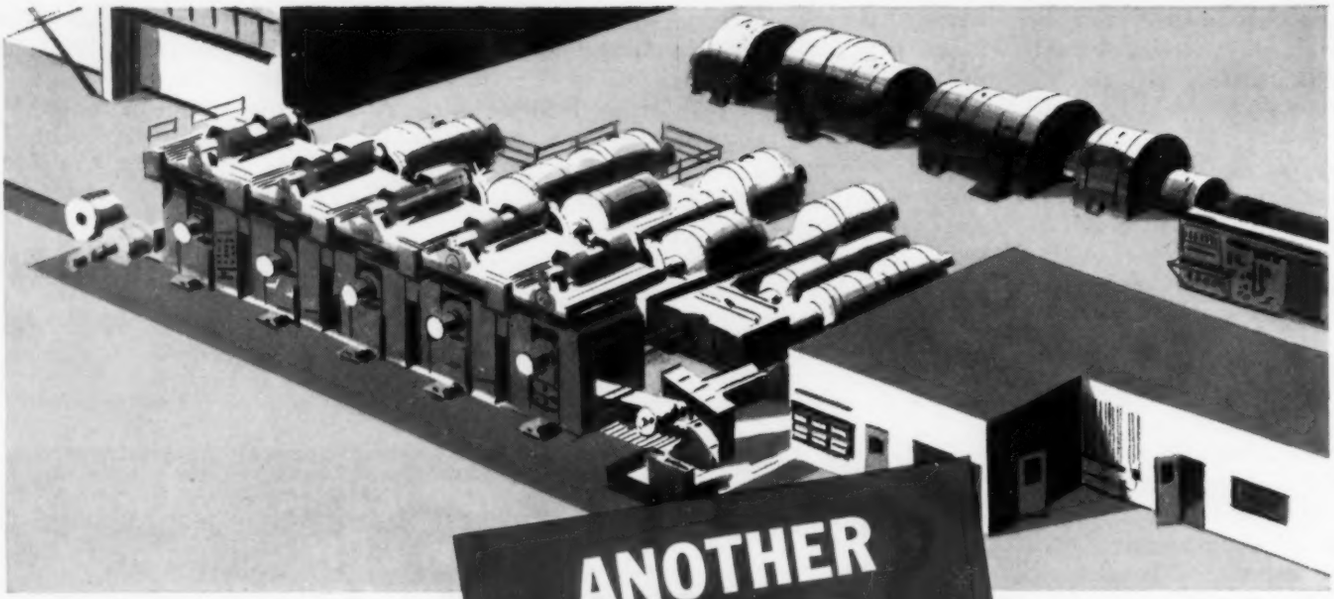
Railroad sidings go directly into the new hall and accommodate 10 freight cars simultaneously. The lighting is twice as bright as in the older halls in the Amphitheatre and a 2,000 car parking lot will be paved in time for the show.

Use of the new hall will permit all general sessions of the Plant Maintenance & Engineering Conference to be held in the arena, directly adjoining the exhibits. These conference sessions, the largest industrial meetings held, attracted more than 2,200 engineers and production heads in January of this year.

Advance registration cards may be obtained from Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y.

▲ The thirty-sixth consecutive meeting of the Metal Treating Institute will be held in Chicago on October 29, 30 and 31.


FORTIFIED FOR EXTRA YEARS OF SERVICE WITH BUCKEYE!
Typical soaking pit installation of Buckeye Silica Firestone.
Thousands of installations in steel mills all over the country prove the greater value of Buckeye Silica Firestone for soaking pits.
Buckeye resists spalling and warpage . . . fights corrosion . . . saves time, labor, and money! Its low expansion assures tight joints . . . reduces down-time to a minimum!
For greater strength and rigidity under high temperatures, use Buckeye Silica Firestone. It can be furnished in various shapes and sizes to meet individual preferences.
For that "something extra" only Buckeye can give, ask for the services of a Buckeye engineer now!
THE CLEVELAND QUARRIES COMPANY
Refractories Department
AMHERST, OHIO
BUCKEYE SILICA FIRESTONE
Bulletin 15-B tells all about Buckeye. Write!
BUCKEYE
"FOR THAT EXTRA SERVICE"
SILICA FIRESTONE



ANOTHER BIG JOB DONE BETTER

WITH NATIONAL BRUSHES
TRADE-MARK

NATIONAL CARBON has, for years, analyzed and supplied the proper brushes for large, steel-mill-production equipment.

TYPICAL EXAMPLE is a five-stand tandem cold mill of the type shown, covering just about the widest range of motor types and brush requirements found in any integrated unit. Calling upon its long experience and diversified product line, National Carbon recommended a specific brush grade for every electrical component in the mill, from pump motors to main drives.

RESULTS were outstandingly successful. Production was established at a high level of availability and has continued at the same rate.

NATIONAL CARBON COMPANY works closely with equipment manufacturers, power companies and principal users of industrial power. Customers know that for *all* motor and generator problems, no other brush supplier can match National Carbon's combination of experience, product-diversification and service-facilities.

Let "National" brushes show you how good really good brush performance can be!

ELECTRICAL AND MAINTENANCE SUPERINTENDENTS!
Give Your Men This FREE Maintenance Course

Mail coupon and receive as many copies as you need — without obligation. Short, entertaining, instructive installments. Profusely illustrated. Quick reference for many day-to-day maintenance problems. Useful for trainees. First mailing includes all back issues.

GET IT NOW!

Send me_____copies of each installment of your DIGEST. I understand that this service in no way obligates me to NCC or to the use of its products.

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

(please print or type) DEPT. IE-10-4

The term "National", the Three Pyramids device and the Silver Colored Cable Strand are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

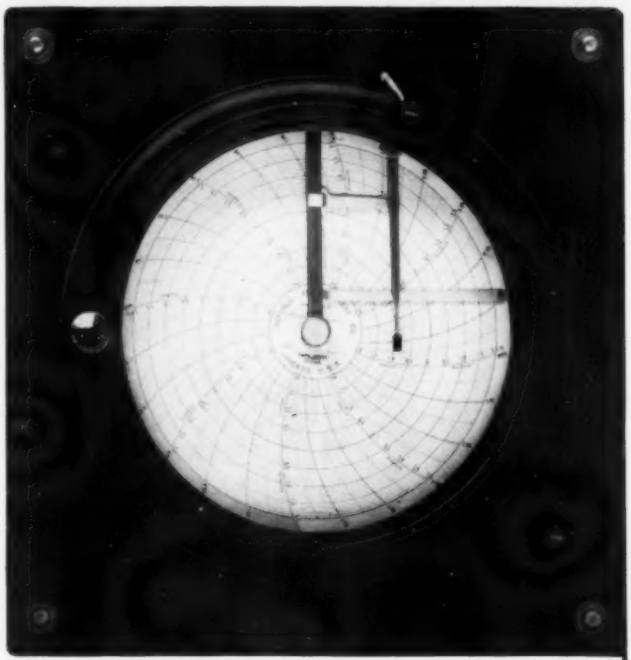
District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
IN CANADA: Union Carbide Canada Limited, Toronto

accurate— sensitive— trouble-free— easy to service—

Four reasons for choosing these Republic Low Pressure Instruments to measure flow or pressure of gas and air

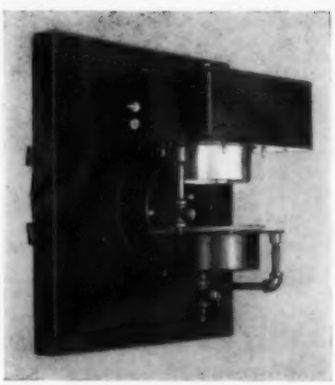
in

OPEN HEARTH FURNACES
SOAKING PITS
REHEATING FURNACES
COKE OVENS
SMELTING FURNACES

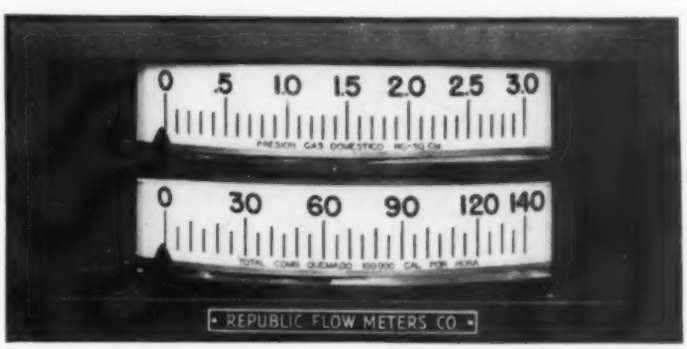


Republic Oil Sealed Bell Recorder at left responds to the slightest changes in furnace pressure and stack draft, and works independently of other controls. Operating principle is so simple that a minimum of maintenance is required. Sealed bell withstands high temperatures and will not crack, rupture or wear out. For pressure or vacuum measurement, the Recorder may be connected directly to a furnace or pipe line. For differentials, it may be connected across an orifice.

Recorder has ranges 0-0.2″ H_2O and 0-8″ H_2O at static pressures to 10 psi. On low range, large 4″ diameter bell gives sensitivity of ±.001″ H_2O.



For quick periodic inspection and cleaning, mineral oil reservoir at rear of Recorder may be lowered by disconnecting one pressure connection and four bolts. Calibration is not changed.

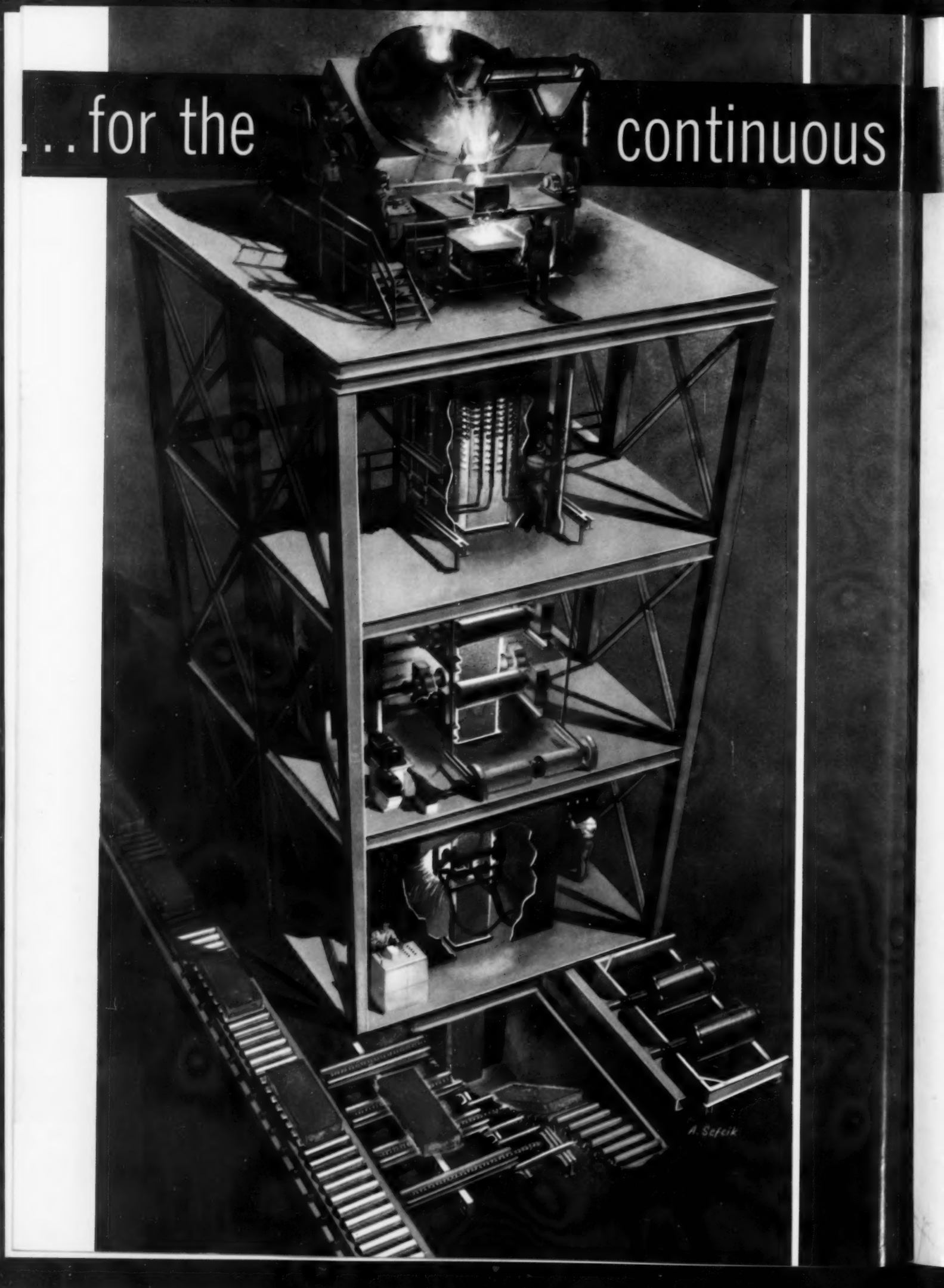


Horizontal Indicator is operated by a tough, resistant diaphragm made of polythylene plastic. Each Indicator is separate and may be individually removed or adjusted. Indicator arm swings on jeweled bearings for friction-free accuracy. Internally illuminated scales may show pressure, draft, pressure-draft combination or differential pressure. Ranges from 0-0.2″ H_2O to 0-40″ H_2O.

Two Indicators are often mounted together to read air flow—gas flow ratio in furnace firing. They may be calibrated so their pointers line up when air and gas are in the correct ratio.

Both instruments fully described in Bulletin 802. Write for your copy today.

REPUBLIC FLOW METERS CO.
2240 Diversey Parkway, Chicago 47, Illinois


...for the
continuous
A. Sefcik

casting of steel

Koppers builds the first commercial-scale machine

THE continuous-casting machine, illustrated here, is now in operation at Atlas Steels Ltd., Welland, Ontario, Canada. This is the first commercial-scale installation in North America that, in a continuous line, converts molten steel into solidified billets or slabs. It was designed and constructed by the Freyn Department of Koppers Engineering and Construction Division.

Atlas Steels' machine is presently producing slabs and billets in three sizes. With different molds, this machine also could produce any desired billet section. It is designed to cast 35-ton heats.

In theory, this new machine could cast a billet or slab of steel many miles in length; it is limited only by the supply of molten metal. In actual practice, acetylene torches automatically cut the molded steel into required lengths as it emerges from the machine.

Continuous casting is an *economical* short-cut in steelmaking. As shown in the "Comparison Chart," the continuous-casting operation can eliminate many laborious and costly steps. Furthermore, the Freyn-design continuous-casting process can yield 10 to 15 per cent more finished steel per heat than conventional pouring methods.

Your inquiry is invited concerning the continuous-casting operation . . . or any other metallurgical construction problems you may have. You incur no obligation, of course.

Designing and constructing continuous-casting machines is just one way in which Koppers serves the steel industry. For any kind of metallurgical construction, you can count on Koppers.

POTENTIAL SAVINGS

Conventional Casting	*Continuous Casting*
MELTING FURNACE	MELTING FURNACE
LADLE	LADLE
CRANE TRANSPORT TO POURING PLATFORM	CRANE TRANSPORT TO CONTINUOUS-CASTING MACHINE
INGOT MOLDS	CONTINUOUS-CASTING MACHINE
RAIL TRANSPORT TO STRIPPER	SEMI-FINISHED PRODUCT
STRIPPER	
RAIL TRANSPORT TO SOAKING PIT BUILDING	
CRANE TRANSPORT TO SOAKING PIT	
SOAKING PIT	
CRANE TRANSPORT TO BLOOMING MILL	
BLOOMING MILL	
SEMI-FINISHED PRODUCT	

KOPPERS®

Engineering and Construction Division

Freyn Department

KOPPERS COMPANY, INC., PITTSBURGH 19, PENNSYLVANIA

Why ALDRICH PUMPS Reduce Maintenance Cost

ALDRICH

Write for catalogs, engineering service or a representative's call. We invite your inquiries.

Design simplicity . . . rugged construction

Aldrich Pumps are built to take punishing service year after year. You can find Aldrich Pumps, today, in good running order after 30, 40 and even 50 years of service. Durability such as this is the result of Aldrich's design simplicity and rugged construction.

Accessibility . . . sectionalization

When wearing parts are due for replacement, in Aldrich Pumps they can be replaced easily, quickly and at low cost. For instance, manifolds can be moved out on the holding studs and you can lift out and replace valves as complete units. . . . Stuffing boxes are particularly accessible—making it easy to renew packing. . . . To meet a change in pressure or capacity requirements, plunger sizes can be changed — in most cases merely by using new glands, throat bushings and packing in the same fluid-end. . . . Wearing parts are interchangeable among pumps of the same stroke size. . . . Fluid-ends are sectionalized to make possible low cost parts replacement and can be made of stainless steel, bronze, Monel or other material.

Aldrich Pumps Are Used for Hydraulic Systems Involving Operations Such As:

Forging	**Stamping**
Extrusion	**Die Casting**
Molding	**Descaling**

Roll Balancing

Water as Hydraulic Medium Cuts Fire Risk

With Aldrich Pumps *water*—as well as oil—can be used as hydraulic medium. With water, you can eliminate chances of plant damage or injuries due to oil fire . . . and you can reduce hydraulic fluid costs.

Representatives in Principal Cities

The Aldrich Pump Company

21 Pine Street • Allentown • Pennsylvania

ALDRICH PUMPS RANGE FROM 10 TO 2400 HORSEPOWER

EF Furnaces for Bright Annealing and Normalizing ---- Continuously

Installation of five EF special atmosphere continuous furnaces bright annealing stainless steel wire.

For Wire, Tubing, Strip and other Products

3000 lbs. of steel tubing, per hour, are bright normalized in this EF gas-fired radiant tube type special atmosphere furnace.

We are in position to design, build and put in operation: continuous equipment for hot or cold rolled, high or low carbon, stainless, silicon, tinplate, aluminum, brass, bronze or any other ferrous or non-ferrous metal—for bright annealing, normalizing, galvanizing, aluminizing, tinning or any other process—in the size and type best suited to your plant, process, product or production requirements. No job is too large or too unusual.

Put your production furnace problems up to experienced engineers—*it pays.*

THE ELECTRIC FURNACE CO.

Salem • Ohio

Gas Fired, Oil Fired and Electric Furnaces

Canadian Associates • CANEFCO LIMITED • Toronto 1, Canada

A large capacity continuous strip normalizing, annealing and galvanizing unit. This is a combination EF gas fired radiant tube and electrically heated installation

Cut-away view of Ajax Spindle Shaft Dihedral Coupling as used between pinion stands and rolls.

AJAX

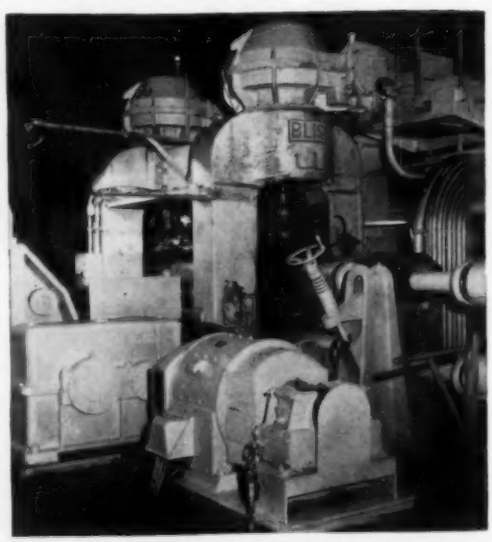
DIHEDRAL
SPINDLE SHAFT COUPLINGS
The Talk of the Show

● Long life and trouble-free operation without the usual high maintenance costs on spindle drives between pinion stands and rolls are made possible by Ajax Dihedral Coupling design. Ajax Dihedral Couplings handle heavy horsepower, high speeds, shock loads and continuous operation under severe rolling mill conditions.

DIHEDRAL PRINCIPLE RESPONSIBLE FOR LONG LIFE, TROUBLE-FREE OPERATION WITHOUT THE USUAL MAINTENANCE

More tooth area is in contact under misalignment than is possible with any other shape of tooth. Load is carried at center of teeth at the point of greatest strength. No end-of-tooth contact to resist free end-float. All teeth are case hardened by induction combining hard wear surface with tough core. Positive seals keep lubrication in and dirt out.

Tell us your misalignment troubles



Showing Ajax Spindle Shaft Dihedral Couplings on Bliss 32"x80" Two-High Temper Pass Mill at the Fairless Plant of U. S. Steel Corp.

- **Handle misalignment heretofore considered excessive**
- **Backlash held to lubrication film requirements**
- **All gear teeth hardened to 50-55 Rockwell C**

FIGURE YOUR COSTS AND YOU WILL FORGET THE PRICE

AJAX FLEXIBLE COUPLING CO. INC.

Representatives in Principal Cities

WESTFIELD, N. Y.

Personnel News...

A. B. Drastrup was elected president of A. M. Byers Co. He succeeds **L. F. Rains,** who retired after 23 years as president and a director of the company. Mr. Drastrup has been executive vice president since February, 1954. He joined the company in 1931 as plant auditor and also served as special assistant to the vice president in charge of operations during the war years. He became manager of steel sales in 1946 and assistant to the president in 1951. Mr. Rains began his career in 1899 with the Wagner Electric Co. in St. Louis. He left St. Louis to spend four years with the Westinghouse Electric and Manufacturing Co., East Pittsburgh. Between 1904 and 1921 he worked in the coal industry in the west and mid west, serving successively as company superintendent, manager, coal jobber, vice president, and for six years, as president of a group of coal companies. In 1922 he became first vice president and general manager of Columbia Steel Co., San Francisco, a company which he helped to organize and which is now a part of U. S. Steel Corp. He left that position in 1931 to become president of A. M. Byers Co.

Walter J. Assel has been appointed engineering consultant on smoke, dust, fume and gas control problems pertaining to steel mills and electric furnaces, by Mechanical Industries, Inc., of Pittsburgh, Pa. Mr. Assel recently retired after serving twenty-nine years as chief engineer of the Steel and Tube Division of Timken Roller Bearing Co. He has been associated with the iron and steel industry all his life, having also served in engineering capacities with U. S. Steel, Minnesota Steel, Republic Steel and Armco.

Robert W. Ertle has been named superintendent of production of the Canton, Ohio, plant of the Timken Roller Bearing Co. He was formerly assistant superintendent of the Canton plant. **Kenneth R. Adair,** formerly assistant superintendent in charge of bearing factory maintenance, has been promoted to the post of superintendent of maintenance, Canton and Gambrinus plants.

Chauncey K. Hubbard has been named general manager of the Container Division of Jones & Laughlin Steel Corp. He succeeds **F. T. Barton** who recently was named vice president, special products and services of the company. Mr. Hubbard, formerly vice president of the Rockwell Manufacturing Co., came to J&L a year ago as assistant to Mr. Barton.

Raymond N. Carlen was appointed assistant to the vice president in charge of operations of Joseph T. Ryerson & Son, Inc. He formerly was assistant operating superintendent at the company's Chicago plant.

August E. Klinger has been named president of Buffalo Steel Corp., now being formed to take over the Buffalo Steel Division, H. K. Porter Co., Inc., recently purchased by Rochester interests. The new corporation will be headed by Chairman **Saul Frankel** with Mr. Klinger returning as president and chief operating officer of the company. **James L. Frankel** and **William S. Truesdell** will be vice presidents. The latter was vice president of old Buffalo Steel. The new corporation will continue to manufacture its general line of steel products and will meet all orders and commitments of Buffalo Steel Division.

Louis M. Marshall has been appointed superintendent of the mason and labor department of Republic Steel Corp.'s Warren District steel plants. Mr. Marshall, formerly general foreman of the department, succeeds the late **J. G. Hanes. Harry L. Anderson** was named assistant superintendent of the department. Mr. Marshall joined U. S. Steel Corp. in Youngstown in 1936. In 1947 he became associated with Republic in Warren, doing repair work in the coke plant and later in the open hearth department. Mr. Marshall was named general foreman of the department in 1952.

Roy B. Young was appointed general manager of the Quebec Iron and Titanium Corp. to succeed F. E. Walling, resigned. Mr. Young was formerly plant superintendent. Before joining Quebec Iron and Titanium Corp. in 1953, he had been associated with the Bethlehem Steel Corp. where he served as assistant general superintendent of the Sparrows Point, Md., coke plant.

A. B. DRASTRUP

WALTER J. ASSEL

ROBERT W. ERTLE

KENNETH R. ADAIR

NORMAN BIRCH

I. EUGENE COX

BERNARD ESAREY

CHARLES E. PETERSON

Norman Birch was appointed vice president in charge of operations of the National Bearing Division of American Brake Shoe Co. **I. Eugene Cox** was named vice president in charge of engineering and development, and **Bernard Esarey** was appointed works manager of the Meadville, Pa. plant.

Charles E. Peterson was named chief metallurgist of Mackintosh-Hemphill Co. He will have a major responsibility for the technical phases of producing cast iron and steel rolls, cinder pots and other company products. Mr. Peterson began his career as an observer in the metallurgical department of the Homestead plant of U. S. Steel Corp. He joined Mackintosh-Hemphill in 1949 as a metallurgical assistant. He left the company in 1953 and until recently was a sales and research metallurgist for the Rolls Division of Blaw-Knox Co.

Dr. Howard S. Turner, director of the research and development division of Pittsburgh-Consolidation Coal Co. since 1948, has been named vice president, research

DR. HOWARD S. TURNER

and development of Jones & Laughlin Steel Corp. He succeeds **H. W. Graham,** who becomes consultant on technology. **Dr. Harold T. Clark,** assistant director of research, becomes director of research.

Edward R. Anderson has been elected vice president of American Brake Shoe Co. Mr. Anderson also continues as president of the AmForge Division of the company.

Charles C. Shackford has been named product engineer of the Electrical Wire Division of the John A. Roebling's Sons Corp.

Robert A. Canning, formerly manager of production engineering, Carboloy Department of General Electric Co., has been named manager of quality control. He was formerly affiliated with American Steel and Wire Co., Worcester, Mass.

Robert B. Heppenstall, Jr., has been named general manager of the Bridgeport, Conn., plant of

ROBERT B. HEPPENSTALL, JR.

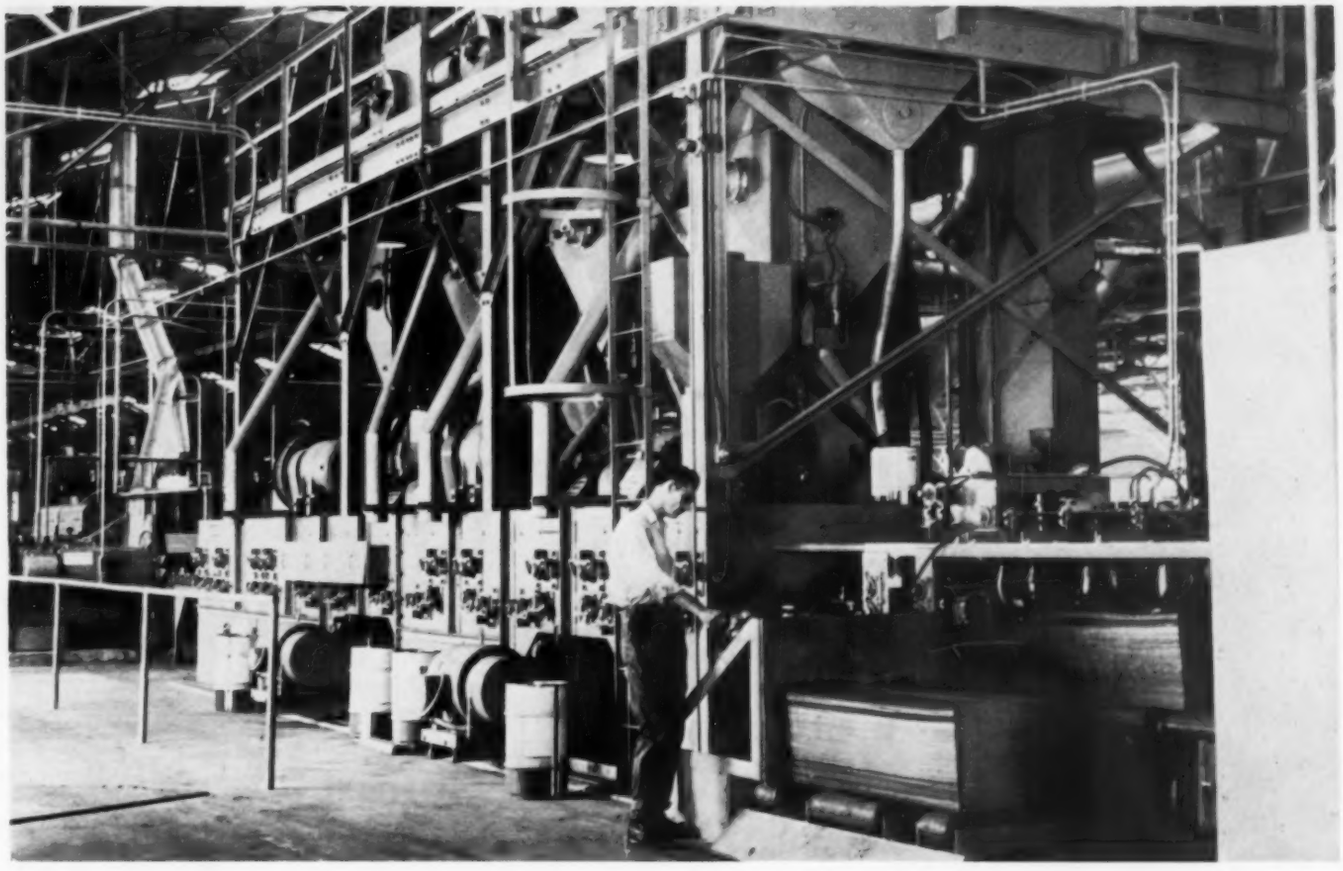
Heppenstall Co. He succeeds **Alfred J. Porter,** who died August 11.

Eugene Mowlds, Jr., has been named general contracting manager of U. S. Steel Corp., American Bridge Division. At the same time, **Marion Chapman** was appointed assistant general contracting manager.

Robert E. Minto has been appointed chief metallurgist of Jones & Laughlin Steel Corp.'s Cleveland Works Division. He succeeds **Don M. Johnson** who has been appointed to a position on J&L's metallurgical contact staff.

Fred E. Harrell has announced his retirement as vice president and director of Reliance Electric & Engineering Co., effective October 31, 1954. He joined the company in 1924 as a sales engineer. Three years

pioneering developments keep WHEELABRATOR® first in blast cleaning



How WHEELABRATOR® MECHANICAL CLEANING

of Hot Rolled Steel Sheets Reduces Cleaning Costs per ton.

Operating results of airless Wheelabrator mechanical cleaning equipment for removing scale from hot rolled steel sheets have proved that other methods do not equal its cost-cutting performance and high speed cleaning efficiency.

In each of the seven drum plants of Rheem Manufacturing Co., for example, Wheelabrator machines have greatly reduced the cost of cleaning 18-gauge steel sheets used in the manufacture of their new Rheemcote lithographed steel drums. In other steel processing plants and steel mills, the Wheelabrator is also effecting impressive results in low cost, high production and providing extra benefits in improved surface cleanliness and better working conditions.

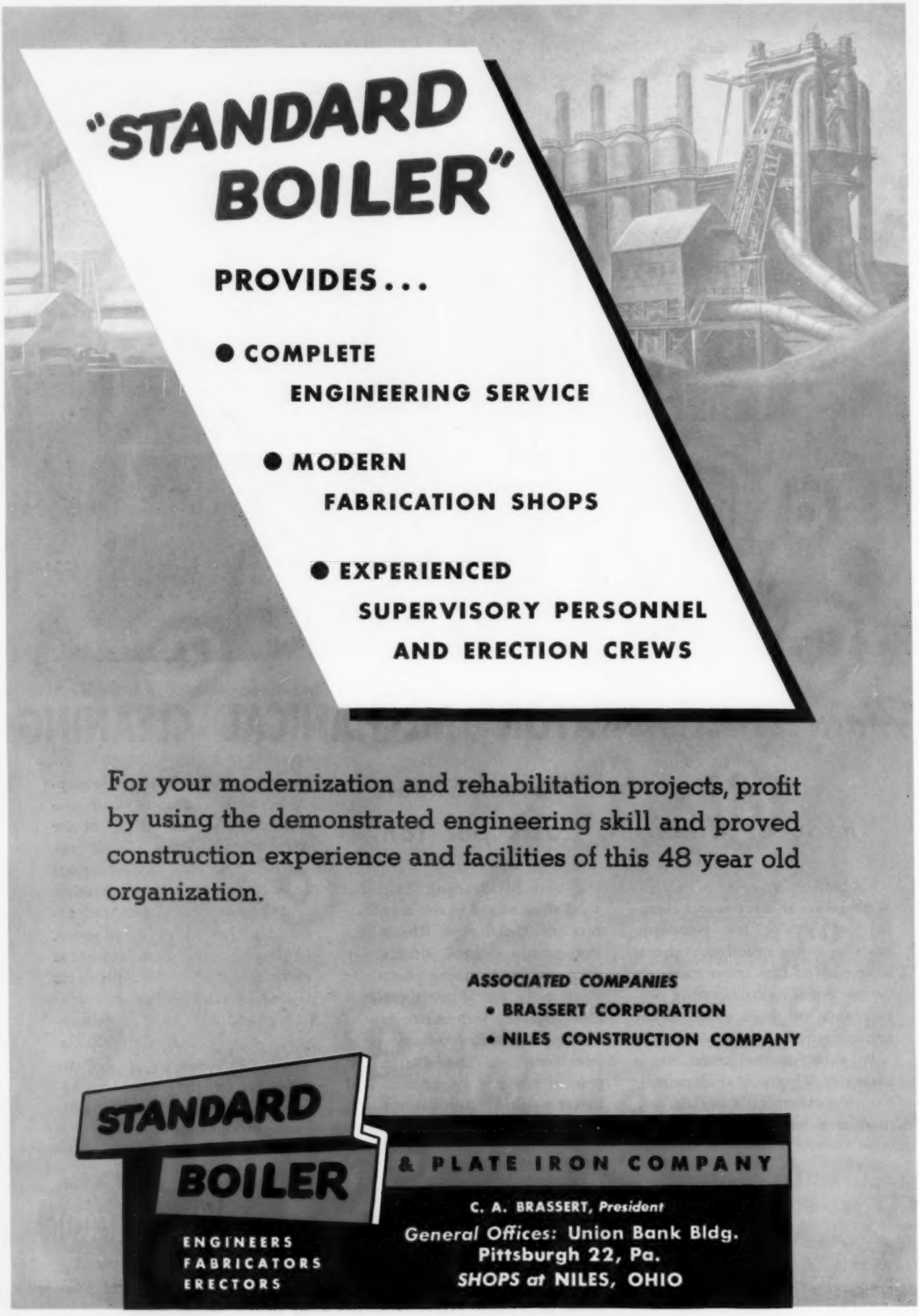
These production economies are a result of perfected equipment design coupled with the controlled abrasive blast of the Wheelabrator unit. With the introduction of Wheelabrator Steel Shot, equipment operating and maintenance costs are extremely low and continuous, high-production mechanical cleaning of hot rolled products is now in actual practice.

We would be glad to demonstrate the savings the Wheelabrator can make for you. Write today for full details and an appointment to see the Wheelabrator in operation.

Bulletin 894 describes the descaling of Steel Strip and Bulletin 914 describes the descaling of steel sheets. Send for your copies today.

American
WHEELABRATOR & EQUIPMENT CORP.
396 S. Byrkit St., Mishawaka, Ind.

Wheelabrator®
AIRLESS BLAST CLEANING



"STANDARD BOILER"

PROVIDES...

- **COMPLETE ENGINEERING SERVICE**
- **MODERN FABRICATION SHOPS**
- **EXPERIENCED SUPERVISORY PERSONNEL AND ERECTION CREWS**

For your modernization and rehabilitation projects, profit by using the demonstrated engineering skill and proved construction experience and facilities of this 48 year old organization.

ASSOCIATED COMPANIES
- BRASSERT CORPORATION
- NILES CONSTRUCTION COMPANY

STANDARD BOILER & PLATE IRON COMPANY

ENGINEERS
FABRICATORS
ERECTORS

C. A. BRASSERT, *President*
General Offices: Union Bank Bldg.
Pittsburgh 22, Pa.
SHOPS at NILES, OHIO

later he entered the home office engineering department, in which he rose to the position of chief engineer in 1943. Two years later he assumed charge of the manufacturing departments.

Philip H. Dreissigacker has been promoted to the position of assistant chief engineer of Farrel-Birmingham Co.

PHILIP H. DREISSIGACKER

John E. Fries, Jr. has been appointed chief metallurgist for the National Bearing Division of American Brake Shoe Co. He will continue to be located at the division's Meadville, Pa., plant, where he was formerly plant metallurgist.

G. A. Andree was named general sales manager of the "Shaw-Box" Crane & Hoist Division of Manning,

G. A. ANDREE

Maxwell & Moore, Inc. He was formerly director of engineered crane sales.

Arthur Sansom was appointed to the sales engineering staff of the Can Machinery Division, E. W. Bliss Co.

Robert L. Bell, formerly superintendent of metals, Carboloy Department of General Electric Co., has been appointed manager of manufacturing engineering.

New cab unit. Parts are even more accessible than in previous models.

Reflecting the experience gained in more than 1000 crane cab installations throughout the past 14 years, these new models offer many advantages.

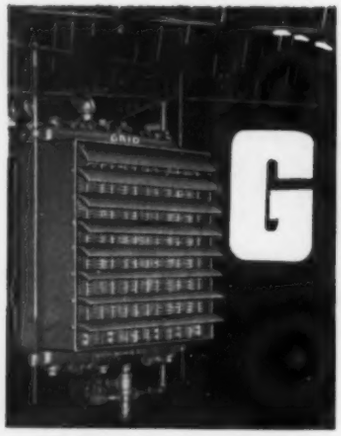
Horsepower is increased, with a 50% reduction in the number of motors used in the condenser unit, yet there are no multiple belt drives to complicate maintenance.

All three models include many features available only in Lintern machines, such as the all-copper integral fin coils for long life and high efficiency, oil separator to protect the compressor, pressure gauges for quick checking of machine operation, dehydrator, blade type condenser fan, oversize drip pan and generous sized drip pan drain, activated carbon and mechanical filter purifying both make-up and re-circulated air, high pressure protective device, vibration eliminators both in the condenser unit and in the connecting lines between the condenser and cab units.

Yet — with all these features we have been able to maintain minimum dimensions for easy, inexpensive installation with unexcelled service and efficiency. Most of the component parts are interchangeable with older models enabling users to keep spare parts inventory at a minimum.

May we send you complete information? Ask for Bulletin 549.

THE LINTERN CORPORATION
ROUTE 20, EAST • PAINESVILLE, OHIO



GRID

UNIT HEATERS
AND
BLAST COILS

The TROUBLE-FREE Heating Service
in the NATION'S LEADING...

Steel Mills

...Since 1929

Maintenance cost conscious steel management men turn to GRID for relief from the continuous expense of heating failures experienced with ordinary unit heaters. GRID service records established since 1929 on units in operation in steel mills throughout the country prove GRID installations provide adequate comfortable heat without constant service care. GRID Units installed in 1929 are still operating today . . . the only attention needed has been an occasional oiling of the motor. No other unit heater can approach this record. It is a record made possible because

GRID is an all cast unit finned hearing sections and headers tested to withstand steam pressures up to 250# P.S.I.

GRID construction uses no brazed, soldered, rolled or welded connections between condenser and headers. A specially designed threaded nipple assures a precision, leak-proof fit.

GRID construction has all similar metals in contact with steam, thus preventing electrolytic corrosion which eventually occurs in copper type unit heaters where steam passes from iron pipes into copper cores. (Write for booklet CORROSION IN UNIT HEATERS.)

GRID construction resists corrosion from fumes present in many steel mills.

GRID design incorporating low outlet temperatures, proper fan sizes and motor speeds, assures delivery of warm comfortable air in ample volume to the working level. No stratification of warm air at the ceiling to waste your fuel dollars.

Eastern Stainless Steel Corp. uses GRID BLAST COILS for sheet drying. Write for Catalog BC-1049.

These are the reasons why steel mill operators get 25 years of trouble-free service. There are units cheaper than GRID, but there is none better. You start saving money the day you install GRID UNIT HEATERS. Get the complete GRID story.

Write for catalog CUH-846-A.

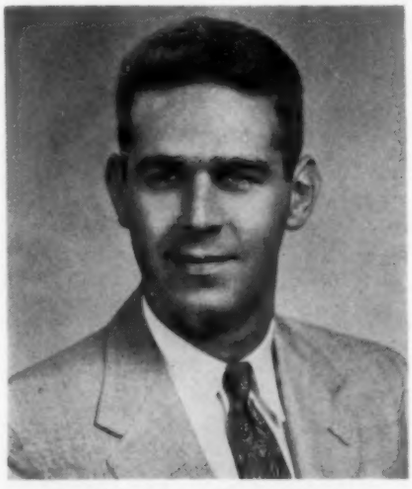
D. J. MURRAY MANUFACTURING CO.
Manufacturers Since 1883 • Wausau, Wisconsin

Representatives In All Principal Cities

Charles H. Schwerin was named manager of the Industrial Furnace Division of the Gas Machinery Co. In his new capacity, Mr. Schwerin will direct engineering, sales, manufacturing and installation of the company's industrial furnaces. He was formerly manager of sales and sales engineering for the George J. Hagan Co.

CHARLES H. SCHWERIN

Luther C. Campbell, Jr., has been appointed manager, Special Products Division for Trion, Inc.

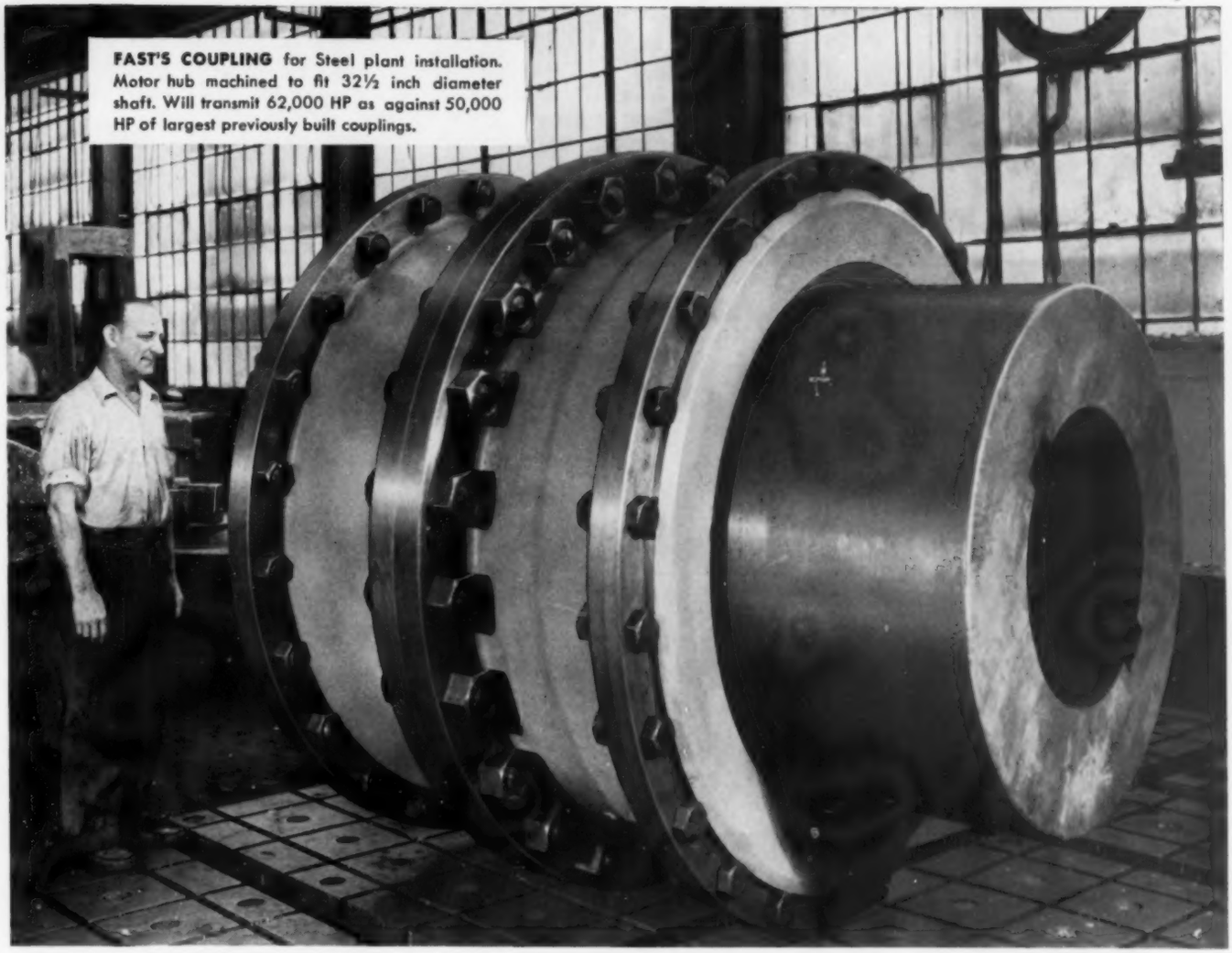


LUTHER C. CAMPBELL, JR.

Call or Write STAMCO for...

Corrugating and Complete Line of Culvert Equipment—Slitting and Coiling Equipment for Ferrous and Non-Ferrous Material in All Capacities—Warehouse and Steel Mill Cut to Length Lines for Shearing and Levelling Sheets from Coils—Shears for Shearing Sheets and Plates Both Underdriven and Overdriven Types in all Capacities up to 1¼" plate.

STAMCO, Inc., New Bremen, Ohio



FAST'S COUPLING for Steel plant installation. Motor hub machined to fit 32½ inch diameter shaft. Will transmit 62,000 HP as against 50,000 HP of largest previously built couplings.

WORLD'S LARGEST INDUSTRIAL GEAR-TYPE COUPLING

To make a coupling that will transmit 62,000 HP and compensate for errors in alignment . . . that's more than a man-sized job.

But Koppers took on the project and this Fast's Self-Aligning Coupling is the result.

After six months of machining and assembly, this huge, *all metal* coupling is on its way to installation in a Milano, Italy, steel mill where it will carry power to a Mesta, 110-inch, four-high reversing plate mill.

It will transmit power from an electric motor to the equipment, and, at the same time, compensate for shaft misalignment and lateral float, give maximum power transmission efficiency, eliminate breakdowns and costly down-time.

WHAT'S YOUR COUPLING PROBLEM?

This mammoth Fast's Coupling is just one example of the outstanding jobs which Koppers is equipped to handle. 35 years of manufacturing "know-how" go into the production of *all* Fast's Couplings, large and small alike. Engineering specialists, experienced in designing Fast's Couplings for special applications, are well equipped to solve your coupling problems.

Remember, there's a Fast's Coupling for every power transmission application. Next time you have a coupling problem, call on Koppers . . . always ready to serve you. No obligation, of course. Also, for full details on Fast's Couplings for industry, mail this coupon.

THE ORIGINAL **Fast's Couplings**

KOPPERS®

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE, MD. This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Koppers Electrostatic Precipitators, Aeromaster Fans and Gas Apparatus.

Engineered Products Sold with *Service*

KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* **310 Scott St., Baltimore 3, Md.**

Gentlemen: Send me FREE, Fast's Catalog giving detailed descriptions, engineering drawings, capacity tables and photographs.

Name .....

Company .....

Address .....

City ..... Zone ..... State .....

Actually see Rust-Oleum applied directly over sound rusted surfaces in your own plant.

Get proof of performance right in your own plant! See Rust-Oleum 769 Damp-Proof Red Primer applied over *your own* rusted metal after simple scraping and wire-brushing to remove rust scale and loose rust. Rust-Oleum's *specially-processed* fish oil vehicle penetrates rust to bare metal—saving time, labor and money.

Rust-Oleum finish coatings in Aluminum, Gray, White, Black, Orange, Blue, Yellow, Green and others provide both *Rust Prevention and Decorative Beauty!* Specify Rust-Oleum for new construction, maintenance and re-modeling. See Sweet's for catalog and nearest Rust-Oleum Industrial Distributor, or clip coupon to your letterhead . . .

There Is Only One Rust-Oleum. It is as Distinctive as Your Own Fingerprint.

RUST-OLEUM®

STOPS RUST!

See local classified telephone directory under Rust Preventives or Paints for nearest Rust-Oleum Industrial Distributor.

ATTACH TO YOUR BUSINESS LETTERHEAD AND MAIL TO:
Rust-Oleum Corporation, 2445 Oakton St., Evanston, Ill.

- ☐ Please Show Me the Rust-Oleum "Rusted Panel Demonstration."
- ☐ Test Application of Rust-Oleum Over Rusted Metal Surfaces in My Plant.
- ☐ Complete Literature with Color Chart.
- ☐ Nearest Rust-Oleum Industrial Distributor.

E. C. Rook has been named vice president and general manager of the Blaw-Knox Equipment Division. He succeeds **G. L. Dirks,** who resigned.

E. C. ROOK

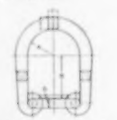
Edward A. Loria was appointed staff metallurgist of Crucible Steel Co. of America, assigned to the central metallurgical office in Pittsburgh. He was formerly associated with the research and development department of the Carborundum Co., Niagara Falls, N. Y., as senior metallurgist. His previous experience includes service as senior fellow in metallurgy at the Mellon Institute of Industrial Research and as assistant metallurgist in the research and development laboratory of United States Steel Corp.

Henry A. Holberson has been elected vice president and general manager of Youngstown Metal Products Co., a subsidiary of the Youngstown Sheet and Tube Co. He succeeds **David W. Thomas** who died August 24. Mr. Holberson joined Youngstown Metal Products in 1935, as a tool and die maker. Three years later he became a tool and die designer, an engineer in 1940 and assistant vice president in 1951.

Charles P. Hammond has joined Cooper Alloy Corp. as divisional superintendent of the company's Hillside, N. J., plant. He was formerly with Green River Steel Corp.

New TM ALLOY STEEL downtown MAGNET CHAIN
lasts 5 to 15 times longer than conventional types!

Locating Plate takes larger joiner links with squared top sections — keeps chain legs separated at 120° centers to reduce friction, twisting and gouging.



- Locating plate keeps legs at 120° centers—eliminates wear —increases life of assembly!
- Made of Taylor Made Alloy Steel Chain—has twice the tensile strength of wrought iron.
- Resistant to shock, grain-growth, work-hardness.

Patent No. 2626175

New Lifting Bail provides larger opening for hook. Heavy, squared-type Alloy Steel construction assures longer life.

Write for free literature!

S. G. TAYLOR CHAIN CO., Dept. H, Hammond, Ind.

the oval-cover, flat-back Pylet

The new "OR" series Pylets with interchangeable features will meet all your conduit fitting requirements for ***machinery wiring . . . plant maintenance . . . and new construction.***

- Accurate, ferrous alloy castings.
- Tapered, machine cut threads.
- Large, flat back area, easily drilled for secure mounting.
- Roomy, smooth interior facilitates wire pulling.
- Well-rounded edges prevent wire damage.
- Self-retaining cover screws.

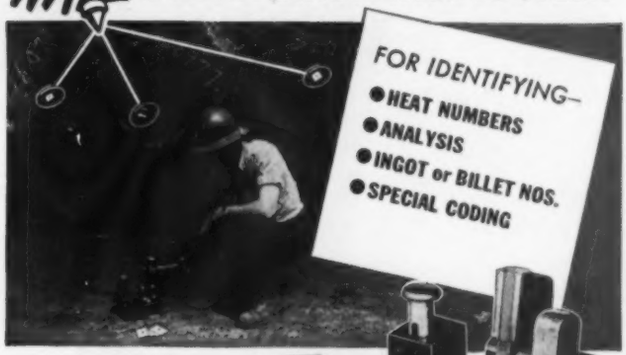
Sold only through authorized distributors.

SINCE 1897

THE PYLE-NATIONAL COMPANY
1383 North Kostner Avenue, Chicago 51, Illinois

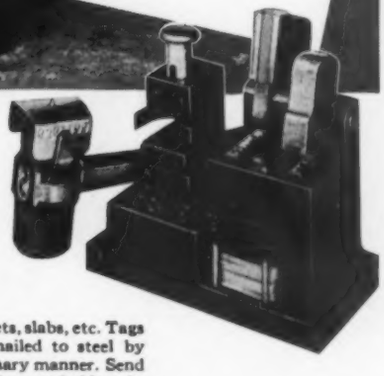
CONDUIT FITTINGS • PLUGS AND RECEPTACLES • LIGHTING FIXTURES

NAIL IDENTIFICATION TAGS TO STEEL!



—with the

"SAFETY" TAG EMBOSSING and TAGGING OUTFIT



It's hard to believe, but it's true—this Outfit enables you to quickly nail metal identification tags to hot or cold steel ingots, billets, slabs, etc. Tags are embossed, pierced and nailed to steel by swinging hammer in the ordinary manner. Send for complete data today on this remarkable unit.

Write for Catalog 100.

Mecco SAFETY MARKING TOOLS

M.E.CUNNINGHAM CO.

1041 CHATEAU STREET, PITTSBURGH 33, PA.

Matt Conley has been appointed district manager for the Timken Roller Bearing Co. Steel and Tube Division in Milwaukee, Wisc. **Bruce Wise** has been assigned to the Timken Los Angeles office. **John Szuhay** has been assigned to the Cleveland office of the Timken company as a sales engineer.

Robert G. Matters was appointed assistant director of research for Allis-Chalmers Manufacturing Co.

J. B. Sewell has been appointed general sales manager of the Garlock Packing Co. He was formerly vice president of the Garlock Packing Co. of Canada, Ltd.

William E. Bailey was appointed Chicago industrial area representative for the application and sale of Dravo Corp. industrial air conditioning. Mr. Bailey has been associated with Dravo for the past 12 years in various engineering and sales capacities. Prior to his present assignment he served in a similar engineering-sales capacity in the Pittsburgh area.

Obituaries

Joseph F. Brehl, sales engineer of National Alloy Division, Blaw-Knox Co. died September 2. He was 47. Prior to joining Blaw-Knox he had been employed at Washington Tin Plate, now Washington Steel Corp.

Richard L. Rossin, 46, of Stanat Manufacturing Co., died September 24.

Arthur E. Jones, president and founder of the Arthur E. Jones Co., Manufacturers' Representatives, with offices in Syracuse and Buffalo, N. Y., died September 19. Mr. Jones had represented the Ajax Flexible Coupling Co., Inc. for 30 years and had been on the Ajax Board of Directors for the past 10 years.

I Wish . . .

to enter one year's subscription for the IRON AND STEEL ENGINEER at $7.50 per year:

☐ Check enclosed
☐ Bill me later

I desire information on membership in the Association of Iron and Steel Engineers:

☐ Application blank
☐ Data

Name_____
Title_____
Company_____
Mailing Address_____

Mail this coupon to:

Association of Iron and Steel Engineers
1010 Empire Building
Pittsburgh 22, Penna.

In all your
PICKLING OPERATIONS

LET THE NEW
WELDCO
MECHANICAL PICKLER

Are you pickling bars, tubing, rounds, flats, squares, or hexagons? Then it will pay you to check these 7 big advantages of the new WELDCO Pickler:

1. Saves 40 to 60% pickling time.
2. Saves on man power, steam, and maintenance work.
3. Uses a minimum amount of chain—often an expensive replacement item.
4. Mechanical operation provides a more vigorous pickling action, exposing all surfaces to the solution and speeding scale removal.
5. Can be built to any capacity.
6. Can be made to fit any type plant.
7. Simplicity in operation and control—no complicated mechanism.

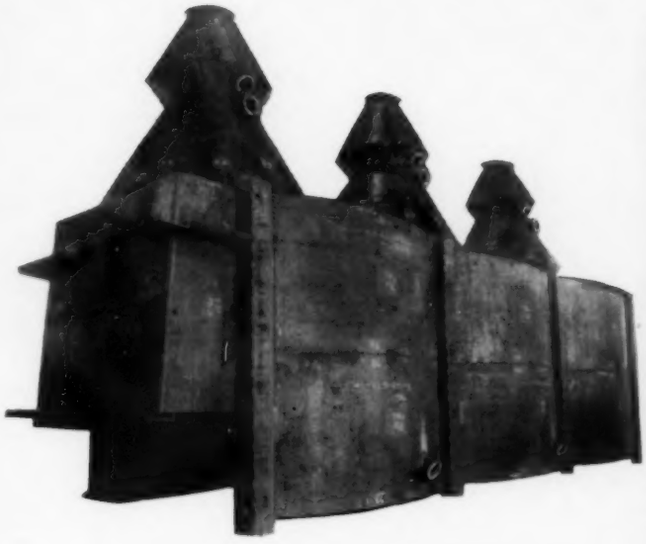
Call or write for complete information on the new, easy-to-use Mechanical Pickler. Our trained engineers will be glad to advise you on such matters as pickling plant layout and design, pickle liquors, temperature control, ventilation, and selection of tanks.

Other WELDCO Pickling Products include Pickling Crates, Baskets, Chains, Hairpin Hooks, Jets, and Scrubbers. Catalogs available on request.

THE YOUNGSTOWN WELDING & ENGINEERING CO.
3700 OAKWOOD AVENUE . . . . . YOUNGSTOWN 9, OHIO

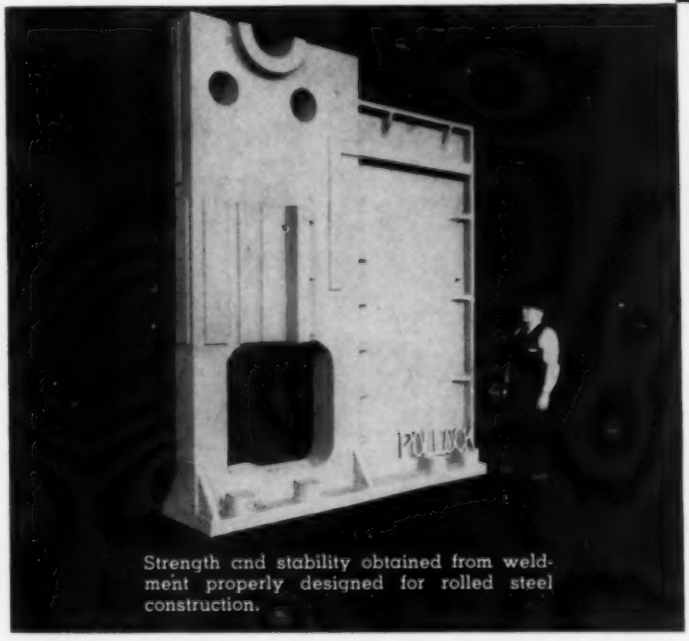
Complete Facilities

for all steel plate fabrication and erection

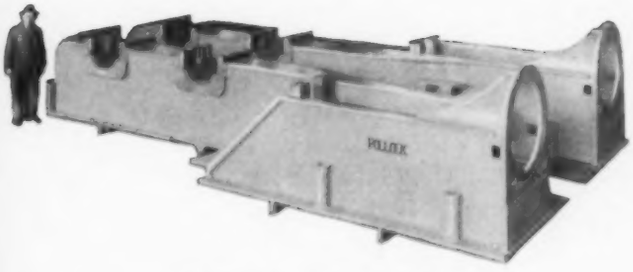


Intricate light gauge steel construction requiring precision fitting.

Complicated pipe connection including carefully fitted hi-carbon liner plates.



Strength and stability obtained from weldment properly designed for rolled steel construction.



Heavy weldment replacing steel casting, making better job and with considerable savings.

BLAST FURNACES • HOT METAL CARS AND LADLES
CINDER AND SLAG CARS • INGOT MOULD CARS
CHARGING BOX CARS • WELDED OPEN HEARTH LADLES

Your steel plate work of all kinds is in safe hands at The William B. Pollock Company. Pollock methods, machines and men have served the steel industry since 1863.

Pollock's modern production techniques and experience help cut your costs on all steel plate work. Precision machines are employed in forming, flame cutting, welding and machining plate from ¼" to 7" thick. If your weldments have finished surfaces or are joined to machined castings, Pollock can do the entire job for you . . . we are prepared to erect in the field the steel we fabricate. Your inquiries are invited.

STEEL PLATE CONSTRUCTION • ENGINEERS • FABRICATORS • ERECTORS

THE WILLIAM B. POLLOCK COMPANY

Since 1863

YOUNGSTOWN, OHIO

Help wanted!

We need your advice
on applications for the new

DRAVO HYDRAULIC BUFFERS

The new Dravo Hydraulic Buffers can be used for hundreds of applications in industry. In *your* plant alone there may be two—or three—or half a dozen places where a Dravo Hydraulic Buffer installation can add safety, protect personnel, save maintenance and eliminate the cost of accidents, and resulting downtime for repairs.

We just don't know of all the places where hydraulic buffers could be applied. That's why we're asking you for your help in spotting possible applications.

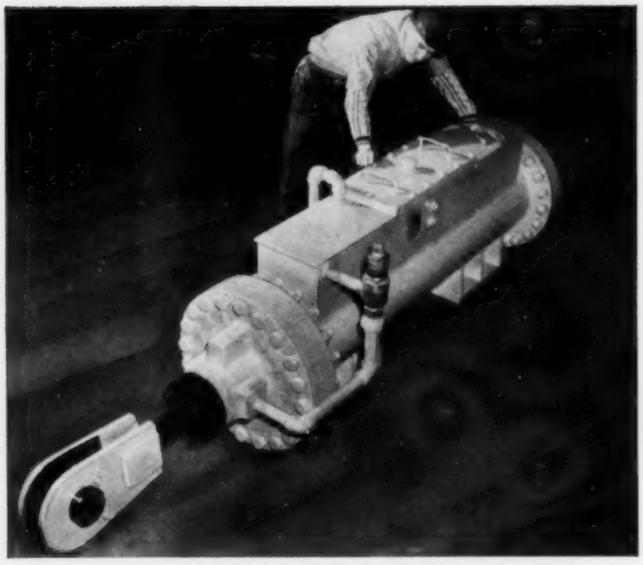
We *do* know that Dravo Hydraulic Buffers are the answer to decelerating and stopping runaway man trolleys on ore bridges when mechanical and electrical braking have failed or bad weather has made braking ineffective on slippery rails. Here the Dravo Hydraulic Buffers act as an auxiliary brake, stopping the man trolleys smoothly and safely. Without the buffers, costly and fatal accidents could occur.

It's up to you now!

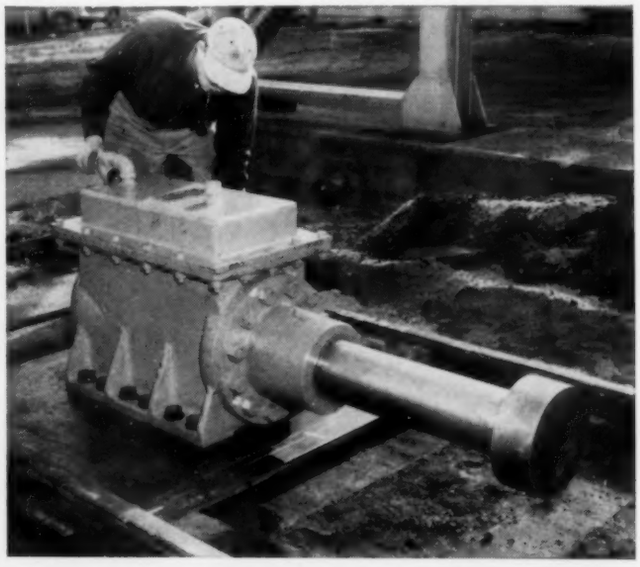
We've engineered these buffers to meet some tough requirements. We've tested them and *know* what they can do and how well they can do it. Several steel plants are already using these buffers successfully.

How about you? Where can you use Dravo Hydraulic Buffers? Let us send you complete information. Then you give us some ideas on possible applications, so we can pass them along to other industrialists who have similar problems. Mail the coupon.

DRAVO
CORPORATION
Neville Island, Pittsburgh 25, Penna.



SIX-FOOT HYDRAULIC BUFFER. This pull-type hydraulic buffer is equipped with a latching device to reset the buffer automatically when its work stroke is completed. Maintenance is low because of the buffer's simple construction. Latching mechanism parts are mounted in self-lubricating bushings. Only periodic inspection is needed to check hydraulic fluid levels.



TWO-FOOT HYDRAULIC BUFFER. This push-type buffer acts on direct contact with equipment. A spring action returns the buffer to normal position. The simple design of the buffer assures a minimum of routine maintenance.

Dravo Corporation
Neville Island, Pittsburgh 25, Penna.

DRAVO

☐ Please send me complete information on Dravo Hydraulic Buffers.

☐ Please have a representative call.

Name_____

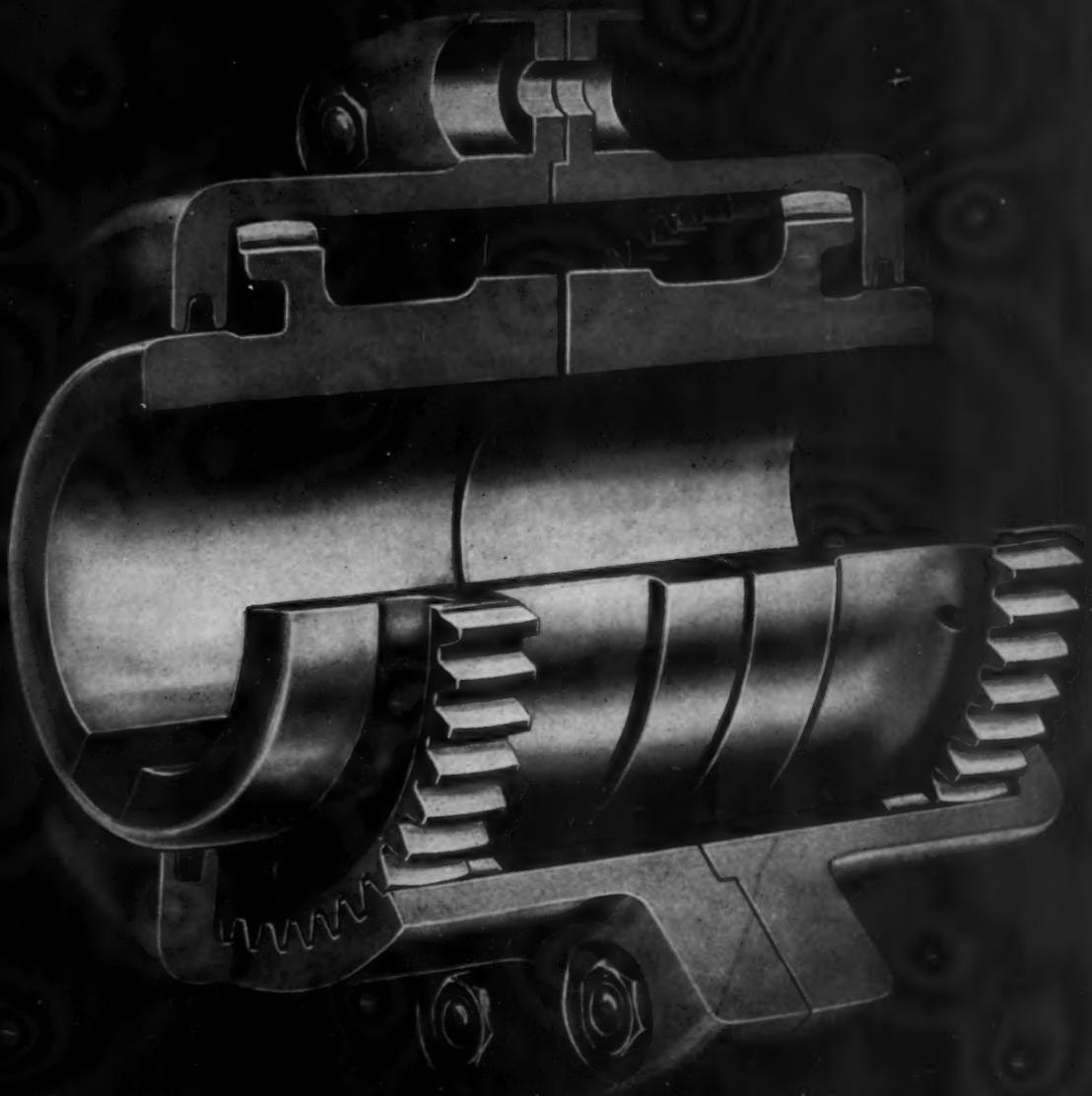
Title_____

Company_____

Address_____

City_____ Zone_____ State_____

POOLE

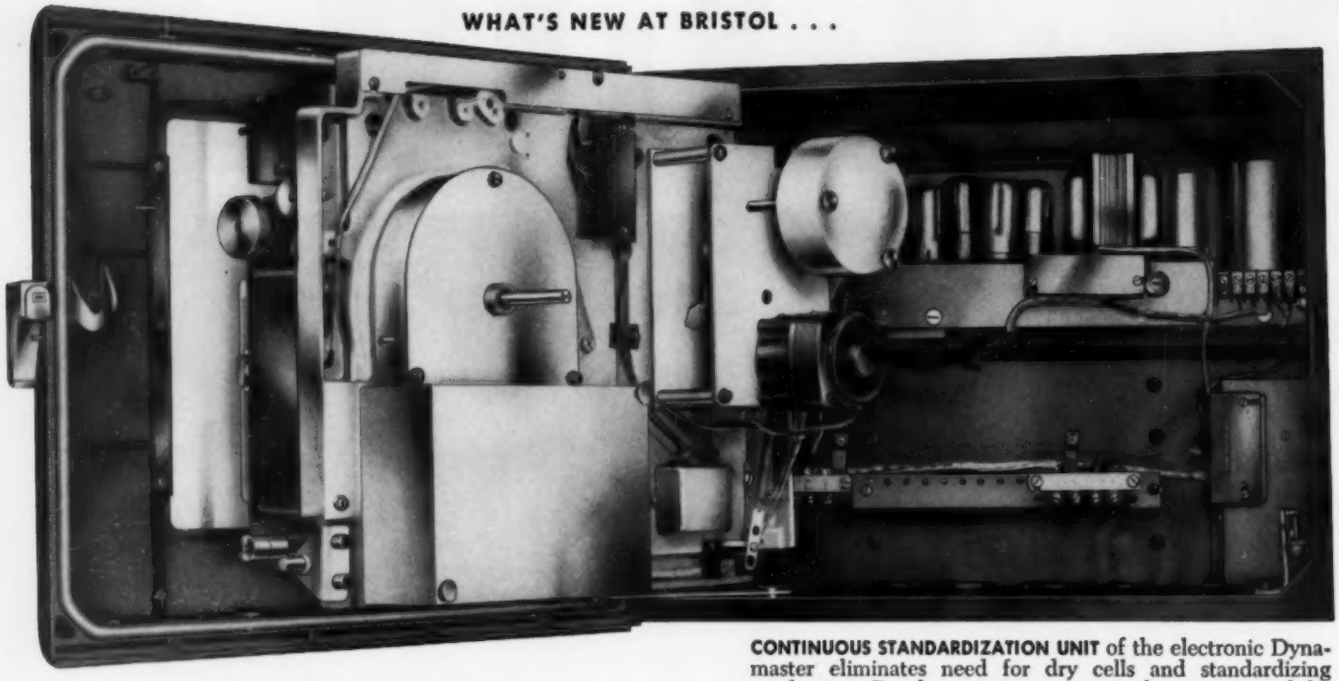


A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.



CONTINUOUS STANDARDIZATION UNIT of the electronic Dynamaster eliminates need for dry cells and standardizing mechanism. Result: no interruptions in the operation of the potentiometer for standardization; no batteries to replace.

No time out for standardization here

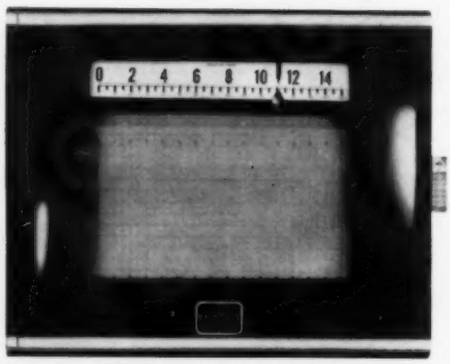
Bristol Dynamaster potentiometer pyrometers give you No-Batt continuous standardization

• You don't have to put up with interrupted performance from old-fashioned potentiometer pyrometers any longer!

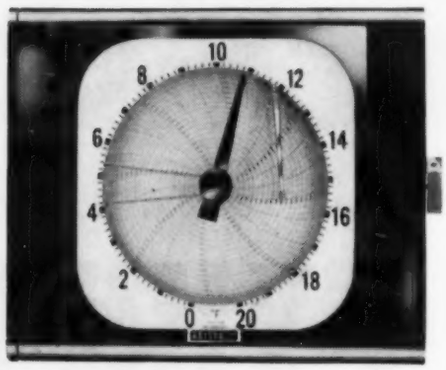
When you use a Bristol thermocouple or radiation-type Dynamaster, you get a *continuous* record or control of temperatures up to 4000°F in any type of fuel-fired or electric furnace or heating equipment. Thanks to the exclusive No-Batt continuous standardization which eliminates the need for dry cells in these electronic instruments, Bristol has been able to do away with interruptions formerly required for periodic standardization.

Bristol electronic Dynamasters are made in round- and strip-chart, single- and multiple-record recorders, air-operated and electric controllers with all types of control actions. Two-pen and program control.

For the complete story on the modern human-engineered Bristol Dynamaster, write for free 35-page booklet P1245. The Bristol Company, 123 Bristol Road, Waterbury 20, Conn.



BRISTOL DYNAMASTER CONTROLLERS in either the strip-chart model (shown above) or round-chart model, may be electrically or air operated. 2 position, 3 position, proportional, manual with automatic reset, or proportional input controls. On - off, proportional or reset air controls.



BRISTOL DYNAMASTER RECORDERS come in easy-to-read round-chart (shown here) or strip-chart models. Single record, multiple record or continuous 2 record designs are available. Bristol also supplies all types of time-temperature program controllers.

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

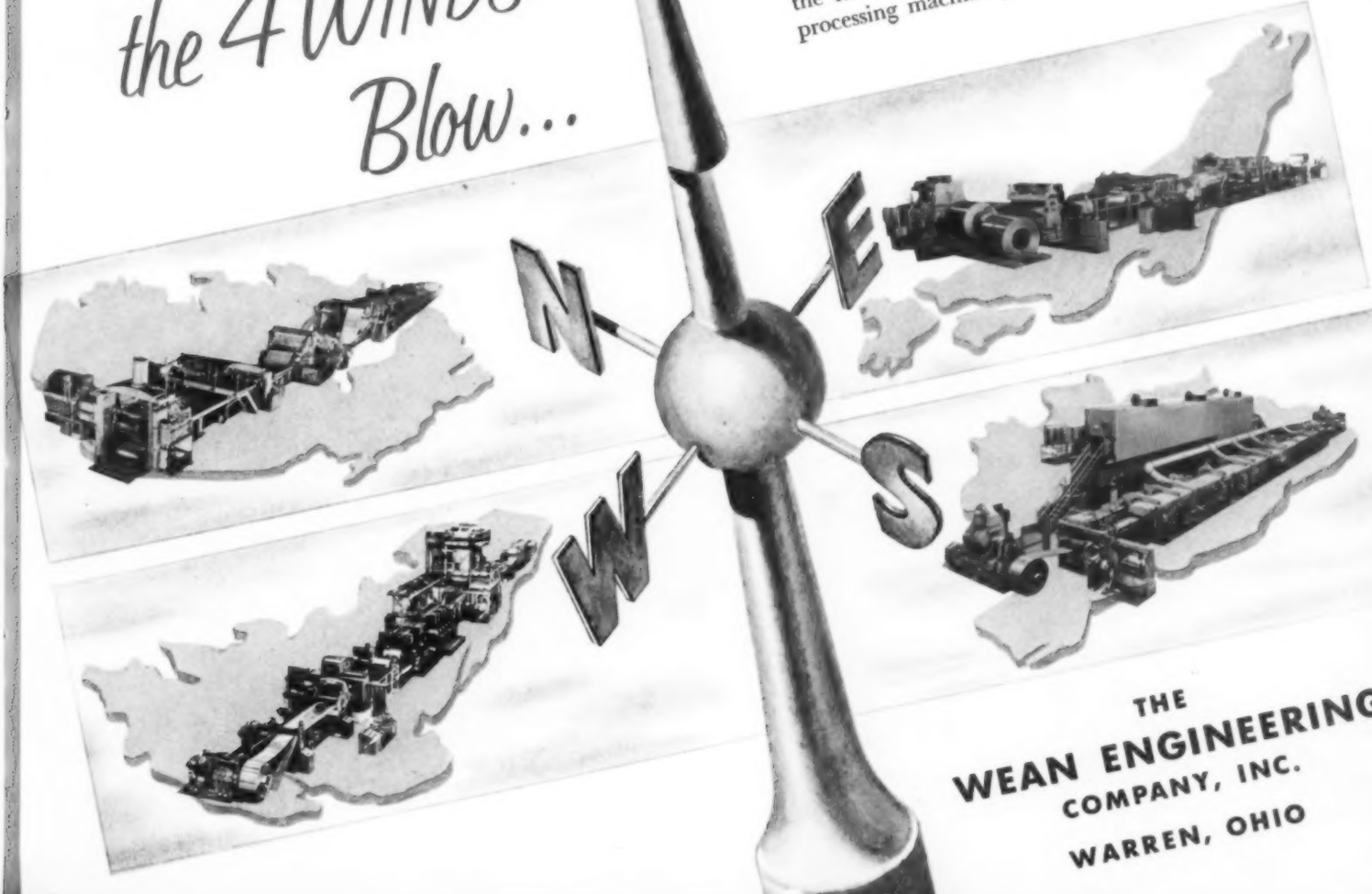
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

WEAN

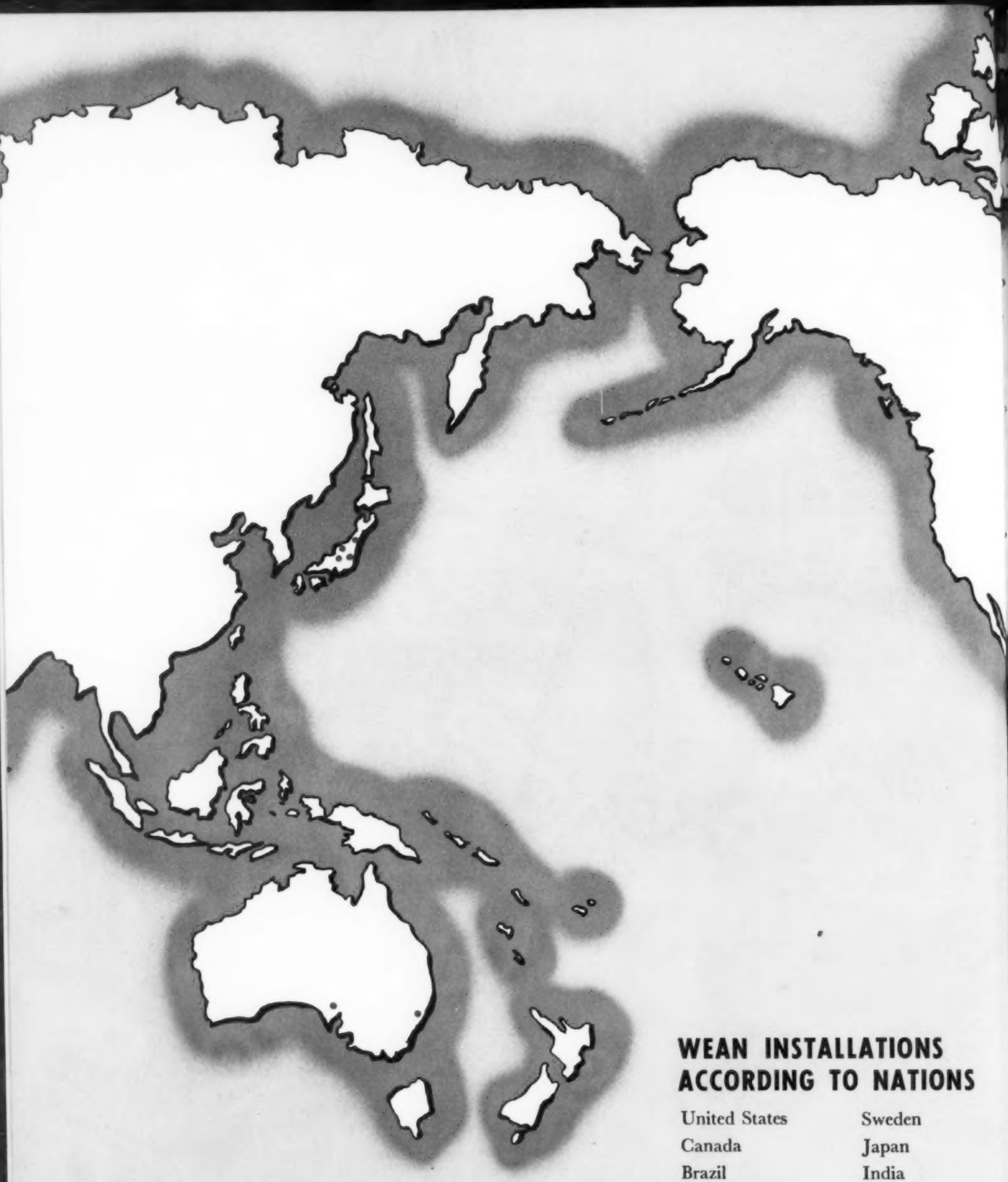
Steel People Recognize Double Eagle Quality

North to Canada, West to Japan, East to England and Europe, and South to Central and South America . . . wherever there's steelmaking you'll find the leaders depend on Wean Engineering for the finest in modern, high speed, automatic steel processing machinery.

Wherever the 4 WINDS Blow...



THE
WEAN ENGINEERING
COMPANY, INC.
WARREN, OHIO



WEAN INSTALLATIONS ACCORDING TO NATIONS

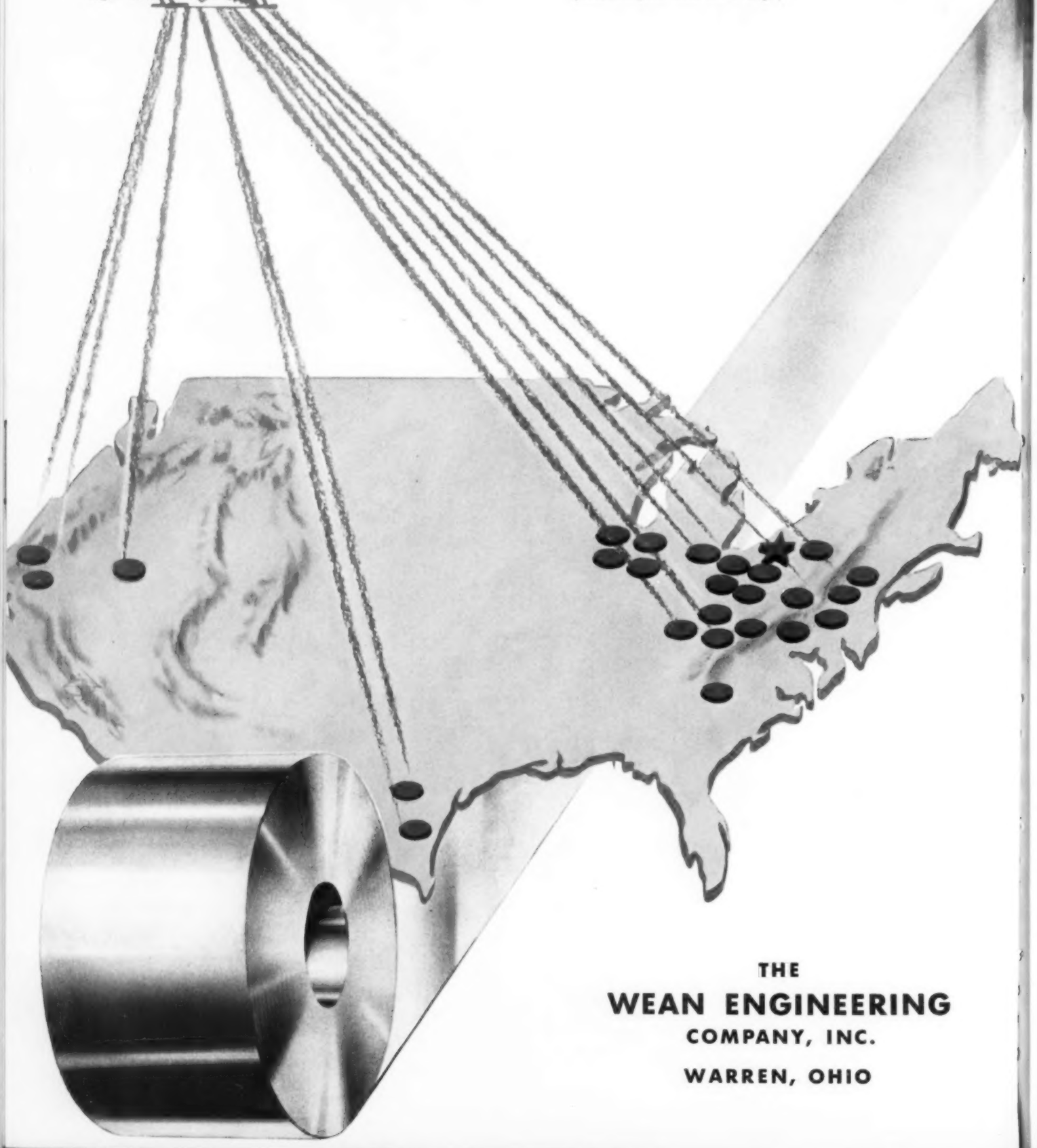
United States	Sweden
Canada	Japan
Brazil	India
Chile	Australia
England	U. of S. Africa
France	Belgium
Italy	Luxembourg
Mexico	Germany

Steelmakers throughout the world have recognized the ability of the Wean Engineering Co., Inc., to design and build efficient sheet, tin and strip mill equipment. As a result Wean engineered lines are as popular with leading Brazilian, English, Japanese, Italian, German, Canadian steel men as they are in the United States. The map on these pages shows the locations of Wean lines now operating outside the continental United States.

WEAN

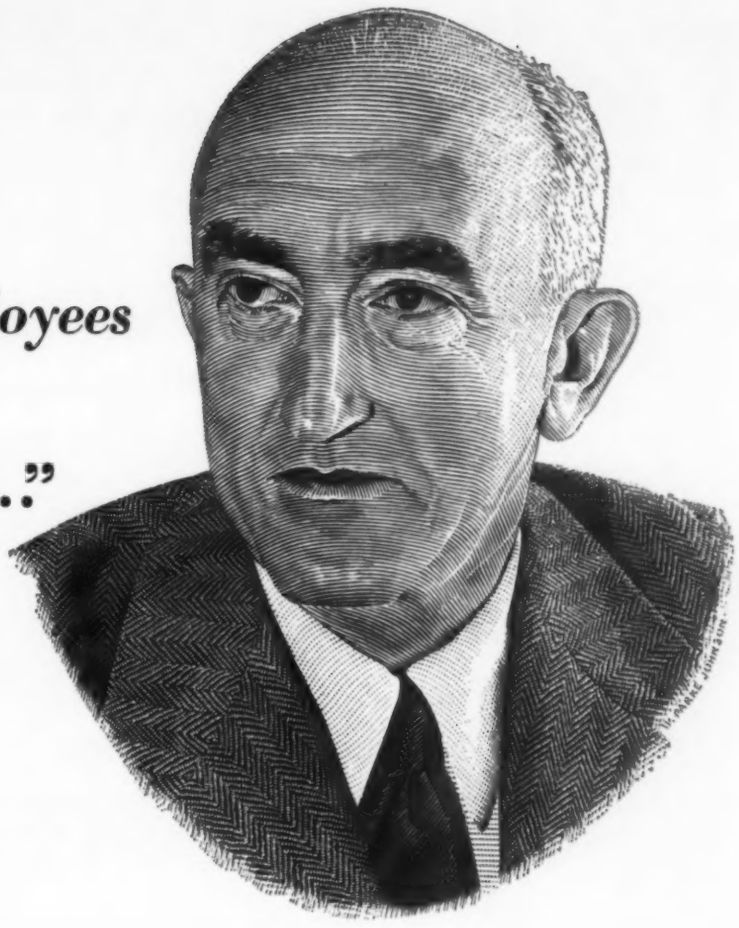
And here at home, too, Wean stands out as a leading designer of modern continuous processing lines. Wean lines are at work in the mills of every leading steel producer and with each succeeding year more and more equipment bearing the Wean nameplate is set into operation.

Wean equipment operating in the United States includes continuous lines for: Electrolytic Cleaning, Electrolytic Tinning, Pickling, Hot and Cold Rolled Slitting and Shearing, Coil Preparation, Side Trimming and Edging, Annealing, Strip Galvanizing (Electrolytic and Hot Dip.)



THE
WEAN ENGINEERING
COMPANY, INC.
WARREN, OHIO

"Boeing's 59,000 employees feel closer to the company..."



WILLIAM M. ALLEN
President
Boeing Airplane Company

"Boeing's 59,000 employees feel closer to the company since our recent successful person-to-person payroll savings drive in the Seattle and Wichita Divisions. Through letters and personal observations many employees have told us they have a greater sense of being a part of the company—that Boeing is interested in the welfare of each and every man and woman on the payroll."

That's the way it is with Payroll Savers. With the realization that systematic investment in U. S. Savings Bonds is a sure road to the down payment on a home, comfortable retirement, or other objectives, comes a better appreciation of a man's job and his company.

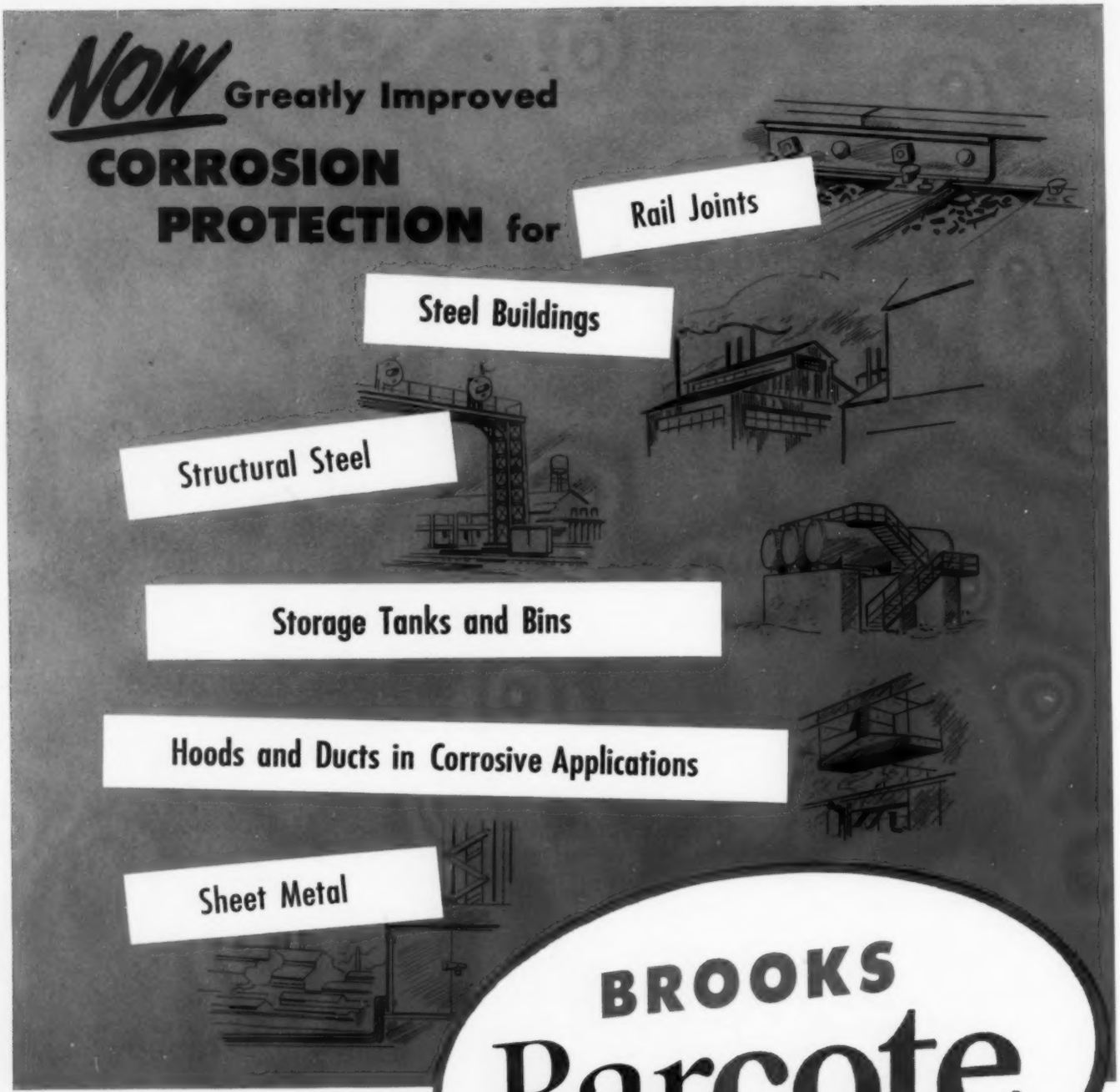
To most Payroll Savers, a day's absence from work means just that much out of his take-home savings. And he no longer takes chances, because he wants to stay off the accident list. He looks for better and quicker ways to do his job—promotion will mean more dollars for Savings Bonds. As a stockholder in America he takes a better interest in national affairs, the sound dollar, and economic stability.

91% of Boeing's 65,000 employees—more than 59,000 men and women—are Payroll Savers, as a result of a person-to-person canvass that put a Payroll Savings Blank in the hands of every Boeing employee. Certainly that is a high percentage of which Mr. Allen may well be proud. But it is not exactly unique. A number of the 45,000 companies which have the Payroll Savings Plan have 90% participation; many are in the 80% to 90% group, and many more are in the 60%, 70%, 80% class. In every case, these high percentages followed a person-to-person canvass that put a Payroll Savings Application Blank in the hands of every employee.

If less than 60% of your employees are Payroll Savers, do something about it. A phone call, telegram or letter to "Savings Bond Division, U. S. Treasury Department, Washington, D. C.," will bring prompt assistance from your State Director, U. S. Treasury Department. He will help you install, or revitalize a Payroll Savings Plan, through a simple, person-to-person canvass which your employees will be glad to conduct.

The United States Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

IRON AND STEEL ENGINEER



BROOKS
Barcote

Brooks Barcote, which sets to a semi-hard coating of pure lubricant, provides exceptional corrosion protection in all the applications indicated. This new leaded-petroleum compound produces a film which expands and contracts without flaking, cracking, pulling away or blistering. Barcote resists the action of salt water, is soluble in petroleum solvents and never clogs spray equipment.

Write for Brooks Pamphlet 61.

- Low cost, with long service
- Flows at 0° F
- Has penetrating action sufficient to carry it behind scale and through rust

THE BROOKS OIL CO.

Since 1876

Executive Offices and Plant, Cleveland, Ohio
Executive Sales Offices, Pittsburgh, Pa.
Canadian Offices and Plant, Hamilton, Ontario
Cuban Office, Santiago de Cuba

Warehouses in Principal Industrial Cities

Equipment News...

VISCOMETER

▲ The Cincinnati Division of Bendix Aviation Corp. and Standard Steel Works of Baldwin-Lima-Hamilton have cooperated in developing a fresh approach to the problem of sulfur absorption from Bunker C (No. 6) fuel oil in acid open hearth furnace operation.

Blending Bunker C with suitable proportions of diesel oil by means of the Bendix Ultra-Viscosor electronic viscometer will reduce the sulfur content of the charge fuel, and yet maintain uniform viscosity and BTU content. This more expensive fuel blend is used only until the slag forms on top of the melt, protecting it from sulfur absorption, then only Bunker C is used. The fuel atomization operation is regulated by maintaining the viscosity of the fuel oil at an optimum value through continuous control of the steam flow to the fuel oil preheater by means of another Bendix Ultra-Viscoson control system. Uniform flame characteristics are thereby achieved.

The adoption of these systems has resulted in real savings in terms of overall reduction in heat time, lowering of furnace maintenance costs and fuel costs.

The viscosity sensing probe is hermetically sealed and contains an explosion-proof junction box. It can be mounted by means of standard pipe fittings, directly into the feed line to the atomizing nozzles. The probe is connected to an electronic computer which translates the damping effect of liquids on the rugged vibrating reed of the probe into viscosity information.

AIR-BREAK STARTER

▲ The Electric Controller & Manufacturing Co. announces a new line of Air-Break starters for 2200-5000 volt squirrel-cage, wound-rotor and synchronous motors.

These starters are built in three styles: 50,000 kva interrupting capacity—with power fuses for systems of 150,000 kva (2300 volt) and 250,000 kva (4600) availability—and in the "Valimitor" (volt-ampere-limitor) style in which air-core reactors limit infinite kva to a finite value within the rating of the starter.

Type ZHA has an interrupting capacity of 50,000 kva. High silicon steel blow-out ears are magnetized from a single blowout coil on each pole and the arc chutes are equipped with cooling plates which remain moisture free for high efficiency to cool and extinguish the fault arc quickly.

Incorporated in the complete starter are safety door-switch on the disconnect-switch compartment, swinging overload panel, self contained bus for group installation, meters as required and cabinet-doors which may be lifted off concealed-type hinges during installation. The contactor is accessible from the front and rear of the cabinet. For reversing service, forward and reverse contactors are mechanically as well as electrically interlocked.

STAMPING FIXTURE

▲ Designed by M. E. Cunningham Co. for stamping required information on the base of 280 MM Shell, is Model 201 HF hard stamping base fixture. It can be made for most any size shell or other round. It also is recommended for a variety of industrial marking applications.

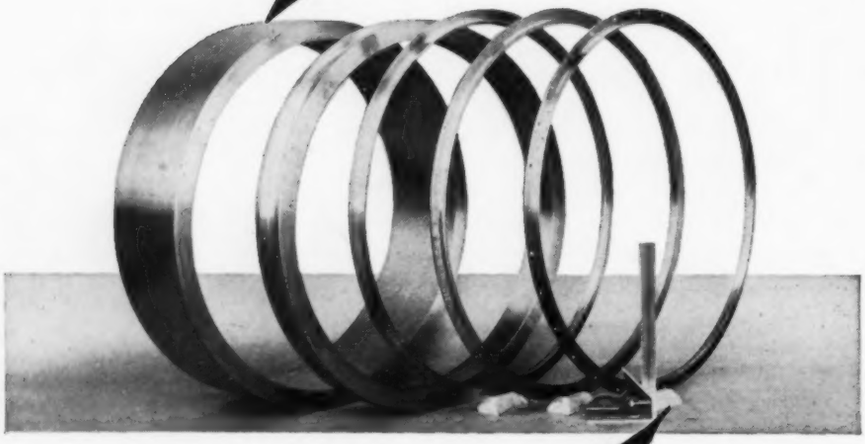
The fixture is constructed to fit over the end of a machined shell. Holes for stamps are machined into fixture to suit combination of marking required and usually follow the circular contour of the shell.

STRAIGHTENER HANDLES STANDARD PIPE LENGTHS

This Mackintosh-Hemphill rotary straightener handles standard lengths of continuous butt-weld steel pipe with O.D.'s ranging from .840 to 2.375 in., and with wall thicknesses varying from .109 to .218 in. Straightening operation is rapidly done and pipe lengths then have no more deviation from straightness than 1/16 in. per ft. Incoming material is received either from cooling racks or storage bins, depending on production schedules. The Model AO machine has six power-driven cross rolls that will straighten pipe at a maximum production speed of 800 ft per minute.

DURASPUN

CENTRIFUGALLY CAST by DURALOY



CUT and FINISHED by THE CUSTOMER

High Alloy rings for jet engines . . . we did the casting and rough finishing and the customer did the cutting and final finishing.

Centrifugally cast metal gives an exceptionally fine, dense, uniform grain structure. The strength of the metal approaches that imparted to a bar or ingot when it is hot forged. It produces an ideal metal for the tough service required of jet engine parts.

Incidentally, as evidence of our knowledge of and experience with tough alloy castings — static as well as centrifugal — the records show very few rejections by this engine manufacturer who subjected each of the many rings we furnished to his own very rigid tests.

May we suggest that you let Duraloy work on your high alloy castings — chrome iron, chrome nickel or nickel chrome? We have the experience and facilities for turning out high quality castings.

10-DJ-4

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa. · Eastern Office: 12 East 41st Street, New York 17, N.Y.

Detroit Office 23906 Woodward Avenue · Pleasant Ridge, Mich.

Atlanta J M TULL Metal & Supply Co. Chicago F O NELSON 332 S Michigan Avenue

METAL GOODS CORP Dallas · Denver · Houston · Kansas City · New Orleans · St Louis · Tulsa

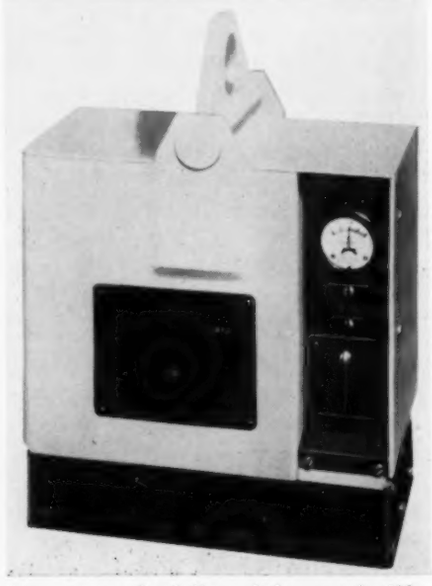
Special spring plungers are used to retain stamps in holder. These plungers hold stamps securely in place during stamping, but can be easily pulled out of unit to change characters as required.

Single character or multiple character stamps can be combined to provide proper spacing and most efficient operation. Each stamp is struck individually to make the complete mark, but this stamping takes less than one minute on each shell.

LIFTING MAGNET

▲ Now available from the Ohio Electric Manufacturing Co. is a self-contained, battery-operated lifting magnet for machine shops, mills and factories.

The new magnet is specially designed for in-plant use since it completely eliminates the hazards of



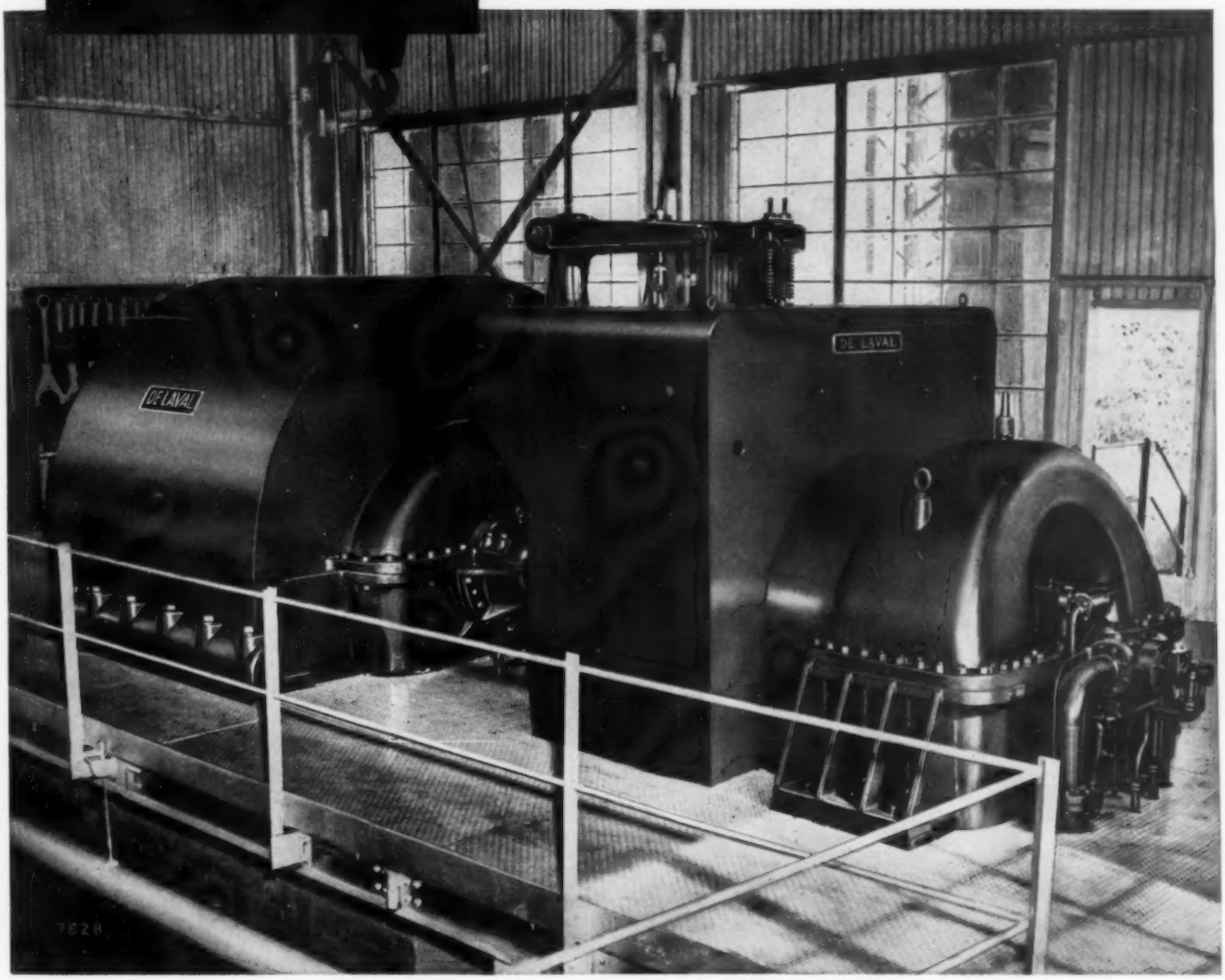
power supply failure inherent in lifting magnets which operate on power from mains. Extremely compact, the unit weighs only 120 lb, including batteries, making it ideal for use on lift trucks or shop hoists.

Lifting capacity of 2000 lb is claimed using six-volt wet-cell automotive type batteries. Length of haul is not restricted by electrical cords or wires.

The magnet is contained within a fabricated steel housing to prevent damage from rough or careless handling. The "Lift-Drop" switch is located on a recessed control panel to prevent inadvertent switch movement. The panel also contains a receptacle for connecting a trickle charger, and a battery-charge indicator. Under normal operating condi-

DE LAVAL CENTRIFUGAL BLOWER

delivers 75,000 cfm for southern steel mill



This De Laval 75,000 cfm blast furnace blower in a southern steel mill is driven by a 9,450 hp De Laval turbine operating at 2,900 rpm. Discharge pressure of the blower is 35 psig.

De Laval blowers have what it takes to give long service. The rugged casings and sturdy, perfectly balanced rotors are built to take punishment. The pressure lubricated sleeve bearings and Kingsbury type thrust bearing add durability and reduce maintenance. Both the turbine and blower are De Laval-designed and De Laval-made for top performance.

De Laval centrifugal blowers and compressors are built in single and multi-stage types to supply air in volumes up to 150,000 cfm for all classes of service in steel, gas and coke plants. The wealth of application experience acquired by De Laval over the years assures a correct and economical solution to your blower problem. Consult your De Laval Sales Engineer.

DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY

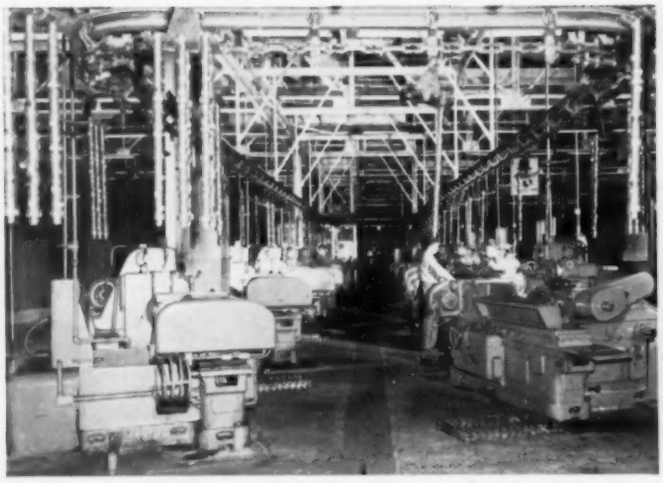
870 Nottingham Way, Trenton 2, New Jersey

DL 262

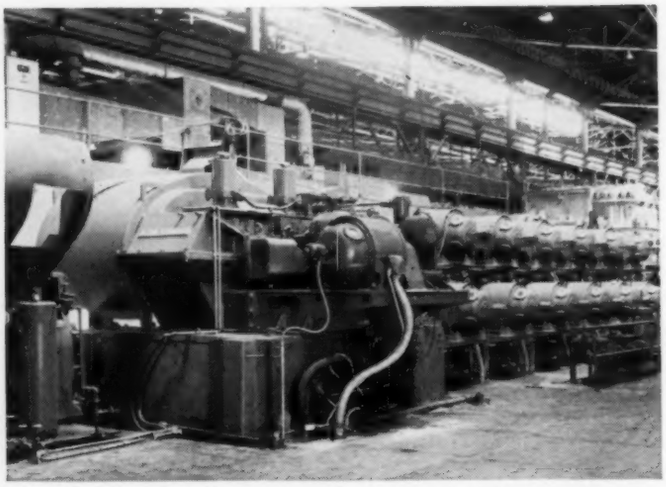
BUILT AND APPLIED BY RELIANCE

THE Tools of Automation

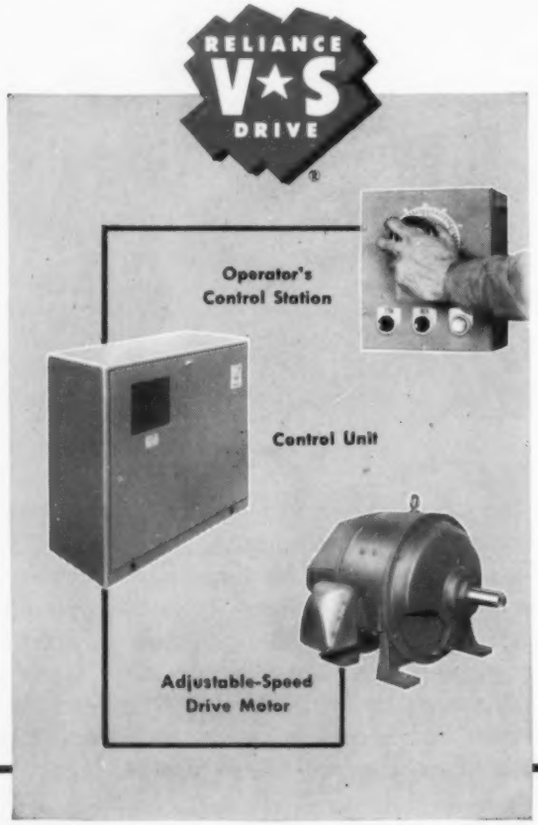
INCREASE PROFITS IN EVERY INDUSTRY



In a camshaft production line, Reliance V★S Drive system provides stepless, easily adjustable speeds for fast, precision machining. Optimum cutting speeds extend tool life, reduce downtime.



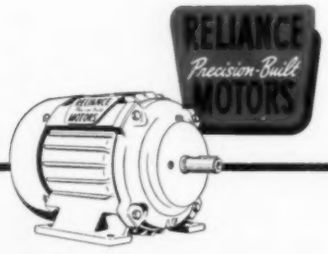
A mile of pipe in 5.3 minutes is made by this Fretz-Moon pipe mill. Reliance Tools of Automation—d-c. motors, regulators, control and application know-how provide synchronization between the forming mill and driving carriage of the flying saw as well as control of the 1000-feet-per-minute speed.



Greater machinery output . . . improved production efficiency . . . both result in increased profits. And both result from using the Tools of Automation: Reliance electric motors, adjustable-speed drives, electronic controls, and applied engineering. They're setting new standards for low cost production in *every* industry.

These Tools of Automation can most efficiently lower your costs, because they're designed and applied to *your* specific situation. Reliance Application Engineers are backed by nearly 50 years' experience in perfecting the drive systems that can help you attain the degree of automatic production you require. For further information, write for the new booklet, "The Tools of Automation".

A-1487-A



RELIANCE ELECTRIC AND ENGINEERING CO.

Sales Representatives in Principal Cities • 1084 Ivanhoe Road, Cleveland 10, Ohio

tions, batteries last from five to 12 eight-hour work shifts without recharging. Other than adding battery water occasionally, no maintenance is required.

FLOW METER

▲ Introduced by the Foxboro Co. is a new electromagnetic flow meter, designed for two in. to eight in. flow lines. Incorporating all the unique advantages of electromagnetic metering, the instrument is additionally rated for unlimited maximum flows, making practical a number of flow measurement applications impossible with ordinary metering equipment.

The meter will measure the volume flow rate of any liquid of sufficient conductance and velocity. Unaffected by the pressure, viscosity, density or changes in conductivity of the flowing liquid, it is recommended for aqueous solutions, slurries, acids and other corrosives, in addition to food and drug products requiring sanitary processing.

The unit consists of a nonmagnetic flow tube with an insulating liner containing flush-mounted metallic electrodes and surrounded by an a-c electromagnet. When conductive liquid passes through the tube, an alternating voltage is set up between the electrodes which varies linearly in proportion to the rate of the flow. Lead wires from the electrodes transmit this voltage output to a new type Dynalog (electronic) Recorder, producing a chart record in appropriate units of flow.

CONTROL SYSTEM

▲ Industrial Nucleonics Corp. is marketing complete control systems for automatically controlling the thickness of cold-rolled strip.

The system consists of a welded steel radiation gage to signal sheet variations, a continuous recorder to present thickness readings, an automatic controller to interpret the signals and provide proper corrections to the screwdown motors, safety devices to insure maximum product and process protection, and an operator's control station at the mill.

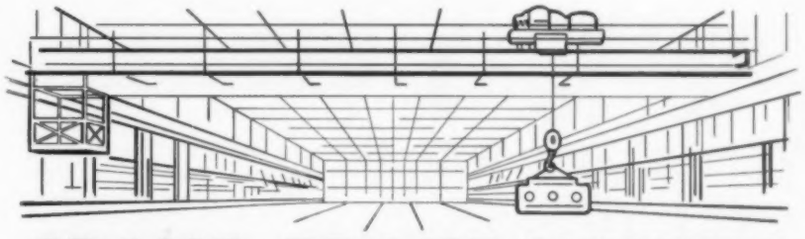
Fabricated of half-inch steel plates, the unit retracts completely into the mill frame to permit easy access to mill rolls. Slide traversing may be either pneumatic or hydraulic.

The operator's control panel, which mounts on the stand, contains a wide strip recorder and gage controls. To initiate control, the operator sets a target knob to the desired thickness and the system takes over the operation. Target settings may be made in thousandths and tens of thousandths (.001-.0001).

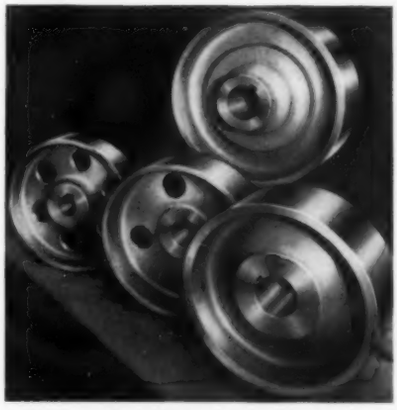
Gage calibration automatically changes to range specified by selector switch—no standard samples are required. An exclusive standardization feature enables the gage to compensate automatically for any variables which might affect the accuracy of measurement such as the accumulation of foreign material on the source and detector windows.

FRACTIONAL HP MOTOR

▲ Designed especially for driving light machine tools and materials handling systems, is a totally-enclosed, split-phase fractional hp motor



CRANE BRAKE WHEELS



A variety of crane brake wheels made by Rosedale.

cast in MEEHANITE® metal by ROSEDALE

• resist distortion
• will not glaze

Crane brake wheels are expected to give good service and long life; early or unexpected failure is something which can't be allowed to happen. That's why several large steel producers regularly specify **Rosedale** Meehanite brake wheels.

Heavy duty wheels are cast in Meehanite metal and have a tensile strength over 55,000 psi. Long use has shown that these Meehanite wheels possess improved freedom from distortion (normally caused by severe usage) and that wheels will not glaze; consequently, constant gripping power is obtained. Wear is evenly distributed over the face as a result of completely uniform metal structure.

Crane brake wheels are only one of the many special types of castings produced by Rosedale for the steel industry which have outperformed all other competitive castings at many installations. If you have any problems involving the use of castings, regardless of application, contact Rosedale.

ROSEDALE FOUNDRY & MACHINE CO.

1731 Preble Avenue, Pittsburgh 33, Pa. • CEdar 1-4007

STEEL TUBING

is the Yoder Way – by cold-roll-forming of coiled strip and electric welding, in compact, efficient and economical Yoder mills. Highly perfected and standardized through years of testing and experimenting by the world's most successful builders of such mills.

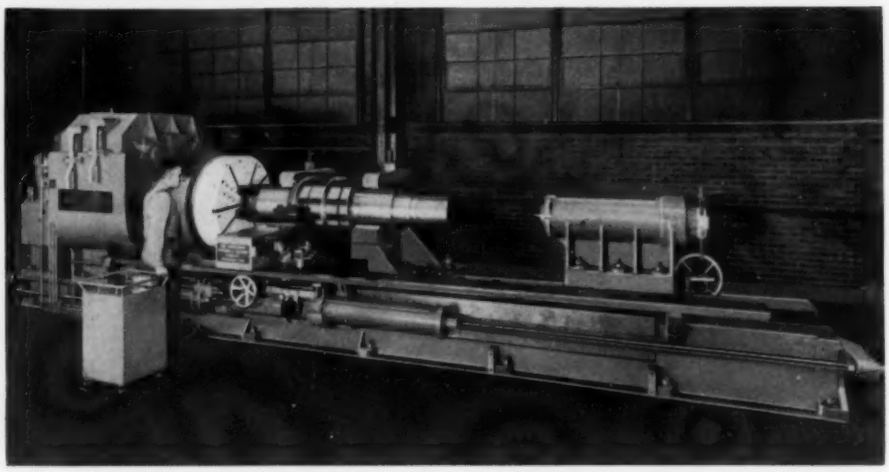
Exclusive Yoder design features save many hours of set-up time and make-ready for each production run. Yoder new 4-in-1 welding transformer, compact, sturdy, and trouble-free, is another reason for high output of quality tubes with minimum scrap losses. Over 200 Yoder mills in operation – list of installations sent on request. Outstanding performance has made Yoder the choice of the big majority of producers making tubing both for sale and for their own use.

Literature, consultations and estimates, without cost or obligation. The Yoder Tube Mill Book answers many questions as to initial investment, cost, production, labor, skill, etc., of electric weld tube making. Ask for it.

THE YODER COMPANY
5495 Walworth Ave.
Cleveland 2, Ohio

Electric Weld
TUBE
MILLS

LATHE TURNS ROLLS ON NECKS OR CENTERS



The Youngstown Foundry & Machine Co. announces a new 36 in. contour roll lathe that turns rolls either on necks or live centers. Speed range is .75 rpm to 53.5 rpm. Roll capacities: 6 in. minimum diameter, 36 in. maximum diameter, with 11 ft 6 in. maximum length (subject to alterations to suit specific needs). Completely hydraulic tracer control insures smoother, more accurate finish. Tool post and carriage are designed to use either single point carbide-tipped tools or regular roll turning tools.

announced by General Electric Co. The fan-cooled motor gives dependable continuous operation under severe conditions of dust and dirt, according to G-E engineers. Large-size ball bearings absorb heavy thrust loads and require no lubrication for ten years' normal service.

Mounting dimensions of the new totally-enclosed motor are the same as for standard open motors of the same rating.

In NEMA 48- and 56-frames, the new motor is available in ratings of ⅙, 1140 rpm, to ⅓ hp, 3450 rpm, 60 cycles. Also available are 50 cycle models.

FORK TRUCK

▲ A completely redesigned model of the Traveloader, a unique side-loading fork truck, has been announced by the Baker-Raulang Co. Originally designed to handle long loads like a straddle truck, stack like a fork truck and deliver like a highway truck, the new Traveloader has improved load distribution, better stability, and higher tractive effort.

Two main features of the new unit, called the T-10-A, include a torque converter drive and springing of all four wheels. The former will make operation more simple for the operator and will eliminate possible maintenance problems in the gear train. Four wheel springing will make for better "roadability" when the truck is used for delivery over highways and streets.

Although the machine has been made wider, turning radius is actually less, providing better aisle spacing, narrower header aisle, and a larger sq ft storage volume.

CLASSIFIER MAGNET

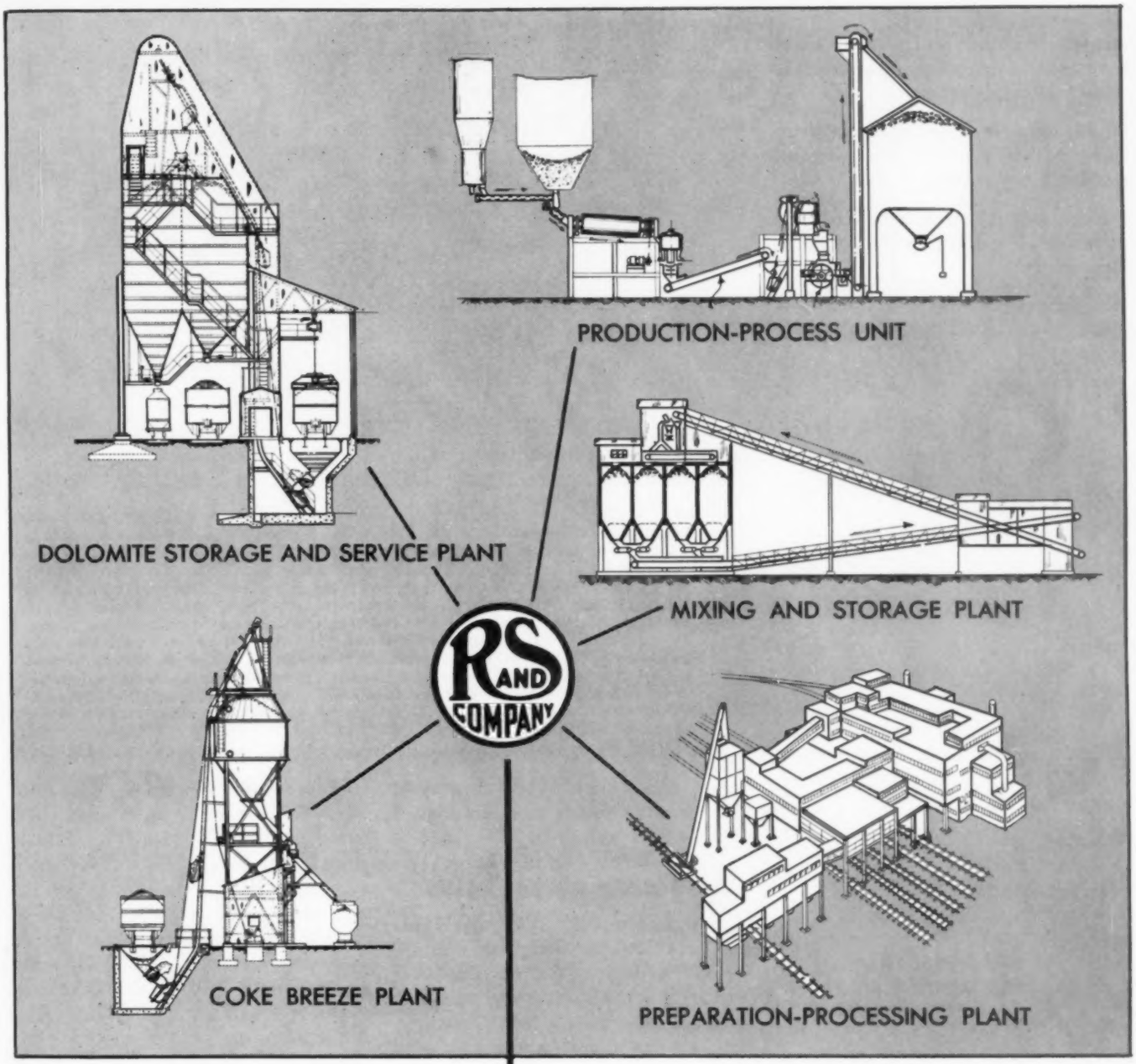
▲ The substitution of non-electric Eriez permanent classifier magnets to replace up to 70 per cent of the old electros has resulted in impressive maintenance savings in tin plate classifier operations.

The permanent magnets are self-energized, hence have no wires or controls to develop short-circuits, no electro coils to burn out; the permanent magnets exert more strength than many of the electros they replace, hence a reduction in the total number of magnets required.

Further, it appears that no diminution in this performance record need be anticipated with the passage of time; the full magnetic power of the Eriez units—may actually be expected to last indefinitely. Tests have shown that even under conditions of severe vibration the Alnico elements lose less than .02 of one per cent of their power in 20 years. Maintenance of the units is nil.

Safer operation, at design speeds, results from the fact that the holding power of Eriez classifier magnets is not subject to fluctuation or failure—as is the case with electros—hence

Designed and built to reduce per ton handling cost



Bulk materials can be handled at reduced cost by properly designed storage and service plants incorporating improved modern equipment.

Roberts & Schaefer Company designs—engineers and constructs—and builds such plants, and has the knowledge and experience to effect greater efficiencies and savings.

If you have bulk materials that are processed, hoisted, transported or stored, R & S complete service can help you. Main and District Offices conveniently located for consultation.

ROBERTS and SCHAEFER COMPANY

130 North Wells Street, Chicago 6, Illinois

Pittsburgh 22, Pa.—1315 Oliver Bldg.

Huntington 10, W. Va.—P. O. Box 570

Hibbing, Minn.—P. O. Box 675

New York 19, N. Y.—254 W. 54th St.

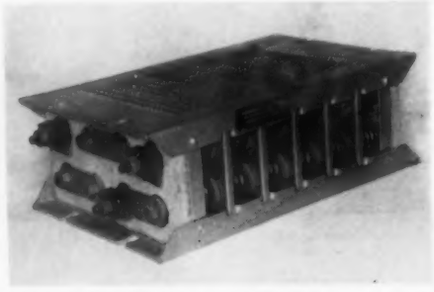
GUYAN
RESISTORS

Engineered and designed to eliminate resistor maintenance on troublesome mill applications.

Non-breakable helical coil construction ends burnouts due to warping and buckling of grids.

Sturdy, rugged steel construction eliminates shock and vibration troubles.

Custom designed for your conditions including excessive graphite accumulations.



With a quarter century of resistor engineering, we invite you to take advantage of our experience.

For complete information on Guyan Resistors, please contact the nearby Guyan Representative or our main plant at Logan, W. Va.

Baltimore, Md.—Durling Electric Co., 2505 St. Paul St.

Birmingham, Ala.—Ebbert & Kirkman Co., 2313 6th Ave. So.

Buffalo, N.Y.—Buffalo Electric Co. West Mohawk St.

Chicago, Ill.—John K. Byrne, 1515 W. Howard St.

Cleveland, Ohio—H. V. Varney Co., 625 Engineers Bldg.

Detroit, Mich.—Plant Equipment Co., General Motors Bldg.

Philadelphia, Pa.—George I. Wright 811 Commercial Trust Bldg.

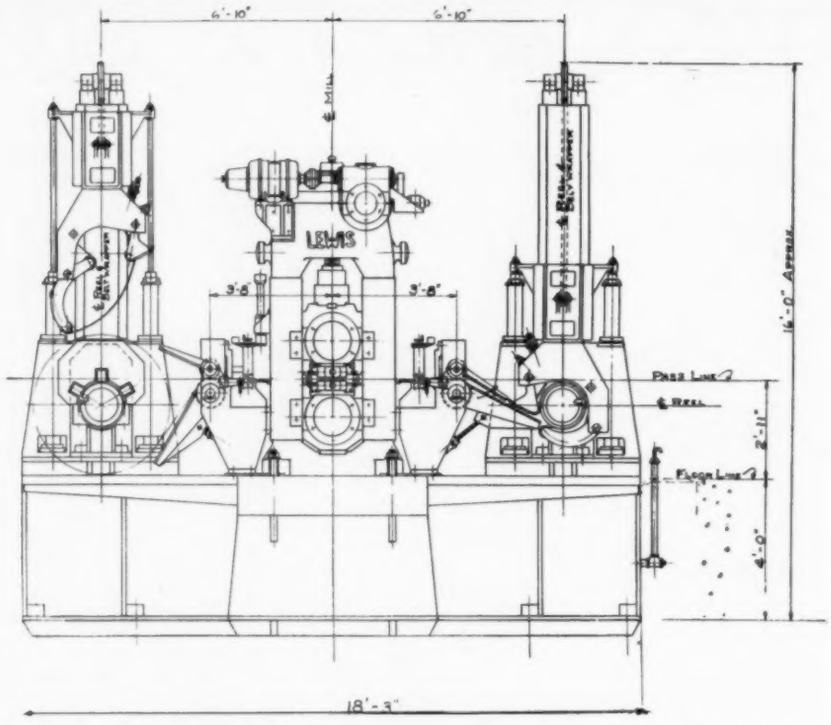
Pittsburgh 27, Pa.—P. R. Holden, 1602 Parkline Drive.

●

GUYAN MACHINERY COMPANY

LOGAN, W. VA.

REVERSING MILL CAN COLD REDUCE OR SKIN PASS



A new combination two-high, four-high reversing mill, designed by Lewis Machinery Division of Blaw-Knox Co., can both cold reduce and skin pass either light or heavy gage material. This versatility is ideal where tonnage requirements are such that there is no justification for the purchase of more than one mill for these operations. Now being built by Lewis, it has two tension reels equipped with belt wrappers and a base plate with integral coolant and lubrication sumps as diagrammed above. Not pictured, but to be included in the installation is a coil box and pay-off reel. The mill will operate at from 600 to 1800 fpm. When used as a 4-high mill (using 4½ and 16 x 20 rolls), it has driven back-up rolls with each roll having its own individual motor without a mechanical tie-in. When used as a 2-high mill (21 x 18 rolls), the same motors and drive are utilized.

can be relied upon to prevent any of the speeding sheets from taking off through the work area.

PLUGS AND RECEPTACLES

▲ Just introduced by Crouse-Hinds Co., new M54 arktite plugs and receptacles feature pressure connector wiring and take any type and size portable cable up to a full 30 amperes capacity at 600 volts a.c. or 250 volts d.c.

Since pressure connectors eliminate the need for soldering, wiring the new plugs and receptacles is accomplished quickly (if preferred, however, connector design does permit soldering); the interior plug assembly lifts out in one piece while the receptacle interior assembly remains intact without either plug or receptacle contacts being removed.

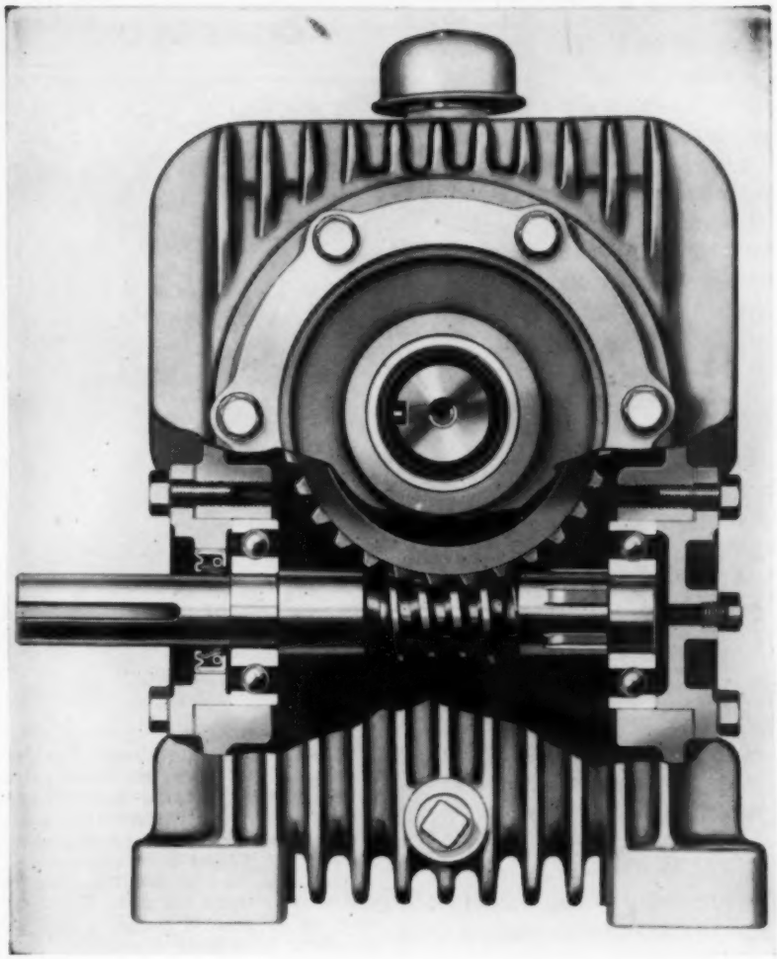
These interior assemblies can be easily interchanged whenever it is necessary to make the plug the "live" member of the two units. Also, since there then would be no exposed energized contacts, a "dead" receptacle may be safely fed from a "hot" plug.

Additional improvements in the new plugs and receptacles are: use of a new aluminum alloy that resists corrosion and does not chip under heavy usage; insulation that has high-arc resistance and low-moisture absorption qualities; and a cable entrance held watertight by a rubber cable bushing clamped by a combination gland nut and strain relief clamp.

DRUM DRYER

▲ Now being produced by Roberts & Schaefer Co. is a relatively high capacity, compact rotating drum dryer of advanced design for drying or heating granular crystalline materials in steel and by-product processing industries. The dryer may be used in production or as a pilot plant unit.

It requires a floor area of only three



•

MORE HP PER POUND

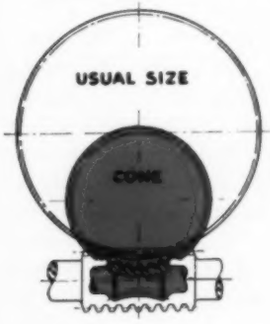
•

MORE HP PER CUBIC INCH

•

MORE HP PER DOLLAR

You're looking at the "innards" of the most efficient worm geared speed reducer available today. It's Cone-Drive Gear's exclusive double-enveloping worm gear design, which means more load-carrying capacity, size for size, than any other type of right-angle speed reducer.



This simple design, with the gear and worm literally "wrapped" around each other, means a space and weight savings that often makes the difference between a compact, efficient product and just another machine.

You can specify (from stock) any one of 190,000 standard models of Cone-Drive gears to handle loads from fractional to 800 hp. You can have ratios from 5:1 to 4900:1. Fan-cooled or water-cooled models available if you should need them.

Interested? Get complete details in Bulletin 8901-50.

TAKE A LOOK AT EFFICIENCY

. . . it belongs in every driven product

CONE-DRIVE GEARS

Division, Michigan Tool Company

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

7171 E. McNichols Road • Detroit 12, Michigan

You Don't Have to "BABY" the

DIAMOND "UTILISCOPE"®
(WIRED TELEVISION)
IT CAN TAKE IT

Operator SEES interior of cement kiln in comfort while "Utiliscope" camera watches in intense heat.

Dirt, vibration, heat are taken in stride by the Diamond "Utiliscope" (wired television). Hundreds of installations in power plants, steel mills, cement plants, coal mines, and a wide variety of manufacturing plants have proved its ruggedness and durability.

Have you investigated the Cost-Cutting Benefits of the "UTILISCOPE"? Mail the coupon for New Ideas

"UTILISCOPE" CAMERA

6944

DIAMOND POWER SPECIALTY CORP. E
LANCASTER, OHIO

Please send me without obligation a copy of new Bulletin No. 1136 showing how the Diamond "Utiliscope" (Wired Television) is being used to cut costs, improve operations and promote safety.

Name_____
Company_____
Address_____

DIAMOND POWER SPECIALTY CORP.
FIRST IN INDUSTRIAL TELEVISION
LANCASTER, OHIO
OFFICES IN 39 PRINCIPAL CITIES
Diamond Specialty Limited — Windsor, Ontario
Since 1903, Diamond has Manufactured Quality Equipment for Industry

ft by five and one-half ft with an overall height of six ft. The location of the surge-feed hopper above the drum permits the hot gases from fuel combustion inside the drum to flow against the incoming material in the surge hopper and thus increase preheating efficiency.

An outstanding feature is the positive pin-sprocket transmission to the rotating drum and also the pin to pin cam transmission to the turntable feeder disc. This all-positive drive prevents slippage at high or low capacity, high or low speed. A variable speed drive permits manual selection of from eight to 24 rpm of drum rotation. Both feeder disc for the release of measured quantity and rotating drum are powered by a single ¾-hp variable speed motor.

A-C WELDER

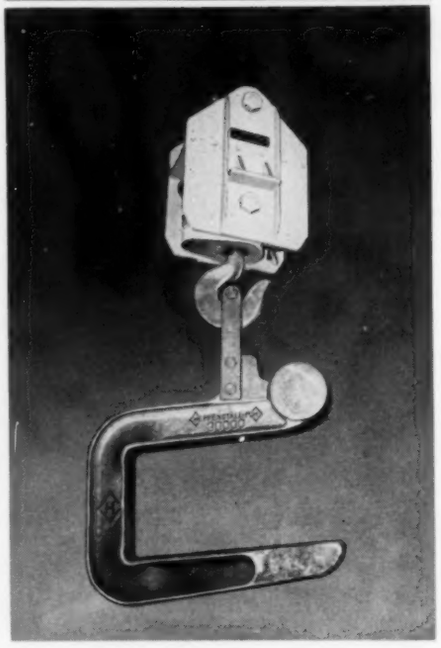
▲ The General Electric Co.'s welding department announces a new industrial line of low maintenance, a.c. welders for high speed production.

Consisting of NEMA rated 300, 400, and 500 amp models, the welders feature stepless current control, silicone insulation, aluminum coil windings, and are equipped with a large current scale, which the operator can read from a considerable distance. Fingertip current adjustment and quieter operation are made possible by a new feature in which the coil supports float in a special rubber bushing.

Highly accurate current settings may be obtained since the welders utilize the moving primary coil design and a large current scale which has wider calibrations in the lower ranges. Current adjustments are accomplished by raising and lowering the primary coil. Simplicity of this design results in a minimum of vibration and mechanical wear and easier maintenance, the engineers said.

Wide current ranges on the new welders (38-375 on 300 amp, 52-500 on 400 amp, and 65-625 on 500 amp) enable them to be used on practically all industrial applications ranging from light-duty, low current, to heavy-duty, high current welding jobs. They are especially suited for heavy section welding where high current is desirable and when arc blow would otherwise cut welding speed and quality.

CRANE HOOK



A line of motorized, rotating crane hooks has been developed by Heppenstall Co. The model shown, with a capacity of 40 tons, was designed for use with the existing crane block. Other models with capacities as low as one ton are available. All operations are controlled by the craneman from his cab. The hook can be rotated through a full 360 degrees, in either direction. Used with a "C" Hook, as shown in the picture, it permits a coil of steel to be turned horizontally as it is lifted. A one hp electric motor furnishes power for turning the hook. A centrifugal clutch of Heppenstall design provides a flexible coupling that prevents overloading the motor.

Additional features include: an automatic hot start which provides an extra surge of current for easier starting, arc stabilizing capacitors, power-factor capacitors, primary switch, and an idlematic control and louvre canopy for adaptation to outdoor applications.

Designated 6WK30L, 6WK40L, and 6WK50L, the new welders are available for 220/440 or 550 volt operation.

CARBURIZING COMPOUND

▲ A non-scaling and selective carburizing compound called "Steelaide" has been put on the industrial market by the Pannier Corp.

The new compound prevents the formation of scale or soft skin (decarburized surface or bark) in the hardening, annealing, normalizing, or forging of steel, regardless of the char-

Tube Mill Practice

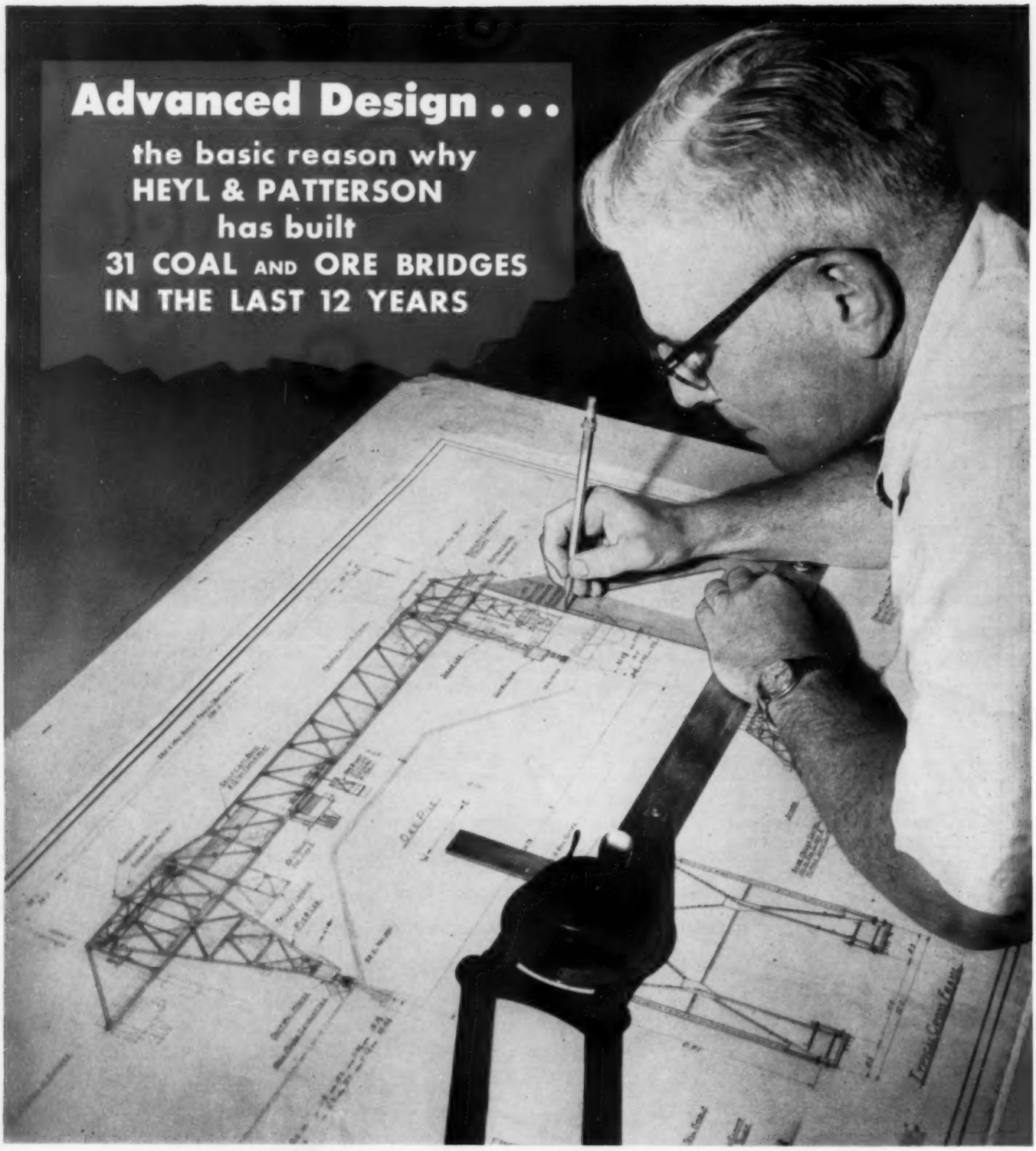
A selection of articles
from the
IRON AND STEEL ENGINEER
on various phases of
tube making.

Practical information on layout and operation of facilities for seamless, butt and electric weld pipe, a field in which little information has been published . . . 23 articles by 20 authoritative writers . . . invaluable for engineers, operators, trainees and students.

8-¼ x 11-¼ in., ... 196 pages, illustrated, clothbound

Price: To AISE Members . . . $2.00
To Others $4.00

ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 Empire Building
Pittsburgh (22), Pa.



The constant aim of Heyl & Patterson is engineering progress based on actual past experience and on modern thinking and planning . . . with the one objective of building better equipment.

Ore Bridges
High Lift-Turnover-Rotary
Car Dumpers
Boat Loaders & Unloaders
Coal Handling Equipment
Pig Iron Casting Machines
Cyclone Thickeners
Thorsten Coal Samplers
Car Hauls and Boat Movers
Coal Crushers
Bradford Breakers

Heyl+Patterson, Inc.
"SINCE 1887"
55 FORT PITT BLVD. PITTSBURGH 22, PA.

acter of the furnace atmosphere. As a selective carburizing agent, "Steelaide" prevents the coated portion of the metal from absorbing carbon so that it retains its original analysis.

RING BALANCE METER

▲ Commonly used for all types of flow metering, the Hagan ring balance meter is now available for a new and unusual application. This is in controlling the water level in high pressure bottle accumulator systems supplying storage for pumps used to operate high pressure hydraulic presses of 2000 psi and upwards.

In this system, the accumulator bottle employed is the air loaded type rather than the individually loaded piston type. The air bottle accumulator system is considered preferable because the total pumping capacity for normal operation of all presses can be reduced to approximately 50 per cent of the total requirement of each press.

The ring balance meter measures the water level directly rather than using the air pressure method in the new application. Changes in the water level cause rotation of the ring which in turn closes or opens mercury switches in a sequential operation, making possible automatic control of the pumps.

Each pump is started by a decrease in water bottle level, actuating the mercury switch at a predetermined point. The pump is stopped as the level increases to the second predetermined point. Switches are staggered to actuate the proper number of pumps to meet the load demand.

ARC WELDING PROCESS

▲ Principal benefits of a new consumable-electrode, inert-gas, arc welding process developed by scientists and engineers of Westinghouse Electric Corp. are higher welding speeds, better quality welds, and lower operating costs. The process has been field tested and is now in production. The field tests disclosed a 15 to 20 per cent faster welding speed at a 25 to 50 per cent lower cost than other manual and semi-automatic inert-gas methods.

"The key to this new welding process," according to W. J. Delaney, Jr., manager of the Arc Welding Department, Buffalo, N. Y., "is a new coated wire. This wire — designated Westing-arc MS-20 wire—is a product of five years of research and development. Its greatest benefits are derived when used with the newly designed welding gun, welding feed-wire control, and d-c arc welder—all components of the new welding system.

The welds produced by this new system can be painted without cleaning as there is virtually no spraying or spatter of electrode material—nor, is there any slag-covering on the weld. The system can be used as a semi-automatic process—where the operator holds the gun; or, as an automatic process—where the gun is clamped into position and the work piece moved. Primarily intended for horizontal and flat position welding, the new process is not yet developed for vertical or overhead welding.

Book Reviews . . .

▲ **"Materials of Construction,"** by M. O. Withey and G. W. Washa has just been published by John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., price $9.00, 6 x 9-in., cloth bound, 870 pp. This is a practical, time-saving, one volume compilation of mechanical properties and uses of the major engineering materials. Causes of defects and variations and how they may be discovered are discussed. Like most materials books, it covers testing equipment as well as such materials as wood, stone, clay products, cement, metals (particularly iron and steels), non ferrous metals and alloys. It may be used as a reference book for engineers and is also suitable for class instruction.

▲ **"Monomolecular Layers,"** a symposium presented on December 27, 1951 at the Philadelphia meeting of the American Association for the Advancement of Science was edited by Harry Sobotka and recently published by the American Association for the Advancement of Science, Washington, D. C. The Book is 9¼ x 6-in., contains 207 pp, is cloth bound, price $3.75 to members and $4.25 to others. This book is aimed to give a cross section of recent progress in monomolecular layers, and the contributors of this symposium have assembled a discussion of their methods and techniques that will direct the reader to more detailed publications on the subject.

Hyde Park

RED CIRCLE Rolls ALLOY-CHILLED

Red Circle Rolls for all Purposes

Hyde Park Red Circle Rolls are outstanding in quality and in performance and are easily identified by the Red Circle.

for
finer finish
long life
greater tonnage
Specify Red Circle

Chilled Rolls
Alloy Iron Rolls
Moly Rolls
Nickel Chilled Rolls
Grain Rolls
Cold Rolls
Sand Rolls

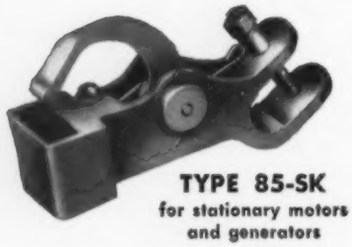
Hyde Park
FOUNDRY & MACHINE CO.
Hyde Park, Westmoreland County, Pa.
ROLLS
ROLLING MILL MACHINERY
GREY IRON CASTINGS

MAXIMUM
motor and
generator
PERFORMANCE
with

FLOWER

BRUSH HOLDERS

TANDEM
for slip ring service



TYPE 85-SK
for stationary motors
and generators

There's a reason for the claim: "maximum motor and generator performance" — long life for both Brush Holders and Brushes is built into the units with highest quality bronze castings, precision machining — proper designing.

Known throughout industry for their enduring qualities, some of these units have lasted more than 24 years, under critical operating conditions. High resistance to vibration and wear assures you, your FLOWER BRUSH HOLDER will not cause breakdowns in production.

GET COMPLETE INFORMATION NOW!

WRITE FOR CATALOG 41

FLOWER PHILADELPHIA SINCE 1909

D. B. FLOWER MFG. CO.

1217 Spring Garden Street, Phila. 23, Penna.

▲ **"History of American Industrial Science,"** by Courtney R. Hall has been published recently by Library Publishers, 8 West 40th Street, New York 18, N. Y., 8¾ x 5½-in., 453 pp, cloth bound, price $4.95. In this book, the author has interpreted a wide variety of facts on American industry in terms of vital matters such as our national defense and the possibilities of future social and political developments in the western world. It is well written and can be of great profit to students who contemplate a business career and to the business man and industrialist.

▲ **"Fatigue of Metals,"** by R. Cazaud, Paris, France, translated by A. J. Fenner was published recently by the Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y., 334 pp., cloth bound, 10 x 6¼-in., price $12.50. This volume is a comprehensive survey of the characteristics and behaviors of metals and is a welcome contribution to current knowledge to this field. The author writes with an exceptional knowledge of not only research, but also points out its present value and inherent possibilities in regard to improved design and the reduction of service failures.

▲ **"Metallurgical Engineering,"** by Reinhardt Schuhmann, Jr. is volume I of a two-volume work published by Addison-Wessley Press, Inc., Kendall Square, Cambridge 42, Mass. It is 9¾ x 7½-in., contains 390 pp., is cloth bound and sells for $7.50. This volume recognizes the need for reorganization of instruction in extractive metallurgy to meet the changing outlook of the metallurgical profession. It has three objectives; namely, to present the subject matter according to basic principles and unit processes rather than in accordance with metals treated; to integrate the science of physical chemistry with metallurgical engineering rather than keep it apart in separate courses; and to put greater emphasis on analysis and quantitative solution of engineering problems with less emphasis on description of current practices.

▲ **"Alternating-Current Machines,"** by A. F. Puchstein, T. C. Lloyd and A. G. Conrad has recently been published in a third edition by John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 9¼ x 6-in., cloth bound, 721 pp, price $8.50. Beginning with transformers, this book shows clearly how to understand, test, predict and calculate the behavior and performance of the most important classes of alternating current power machinery. It offers a complete treatment of machine reactions based on modern practice, contains expressive, self-identifying terms, notations and symbols, and it sets forth up-to-date problems which have been incorporated to test understanding of the theoretical applications. This third edition contains a 20 per cent enlargement over the previous two editions.

▲ **"Basic Mechanics of Fluids,"** by Hunter Rouse and J. W. Howe was published recently by John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 245 pp, 9¼ x 6-in., cloth bound. The book is one dealing mainly with mechanics of fluids for all classes of engineers. It provides a sound basis for the subject. This book is a unified, coherent development rather than a series of statements of principles, and effort has been made toward the realization of general methods of analysis rather than of solving particular problems.

"...within man's power"

Monumental achievements have marked each era of mankind. Within reach of future generations is the conquest of tuberculosis.

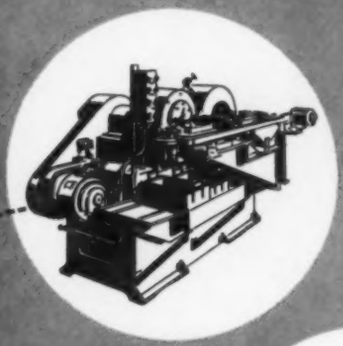
It is within man's power to eradicate tuberculosis—when you buy Christmas Seals to support your tuberculosis association you help to make this possible.

This year use Christmas Seals generously—and send your contribution today, please.

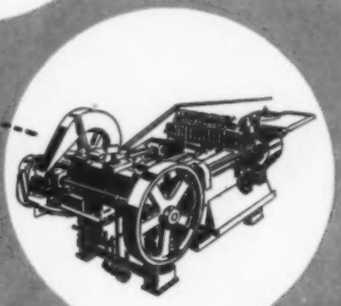
buy Christmas Seals

This space contributed by
IRON AND STEEL ENGINEER

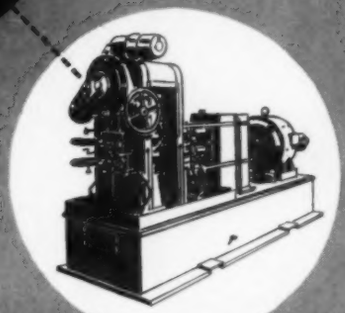
5 KINDS OF WATERBURY FARREL ANSWERS TO YOUR MASS PRODUCTION PROBLEMS



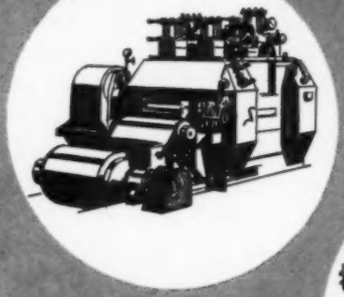
COLD PROCESS BOLT & NUT MACHINERY — Headers (all types) • Rivet Machinery • Trimmers • Thread Rolling Machines • Slotters • Nut Formers and Tappers, etc.



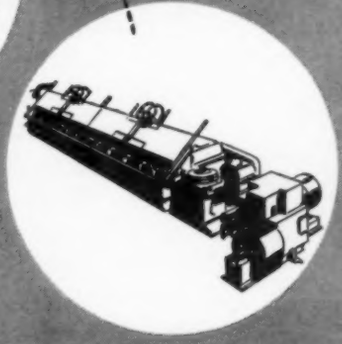
POWER PRESSES—Crank, Cam and Toggle; also Rack and Pinion Presses • Eyelet Machines • Multiple Plunger Presses • Horizontal and Hydraulic Presses, etc.



MILL MACHINERY — Rolling Mills: Strip, Rod, Wire Flattening, (For Ferrous and Non Ferrous Metals) • Also Slitters • Straighteners • Cut-off Saws • Coilers • Winders, etc.



SPECIAL MACHINERY — Sendzimir Mills • Small Arm Ammunition Machines • Collapsible Tube Machines • Coining Mills, etc.



WIRE MILL EQUIPMENT — Continuous Wire Drawing Machines (Upright Cone and Tandem) • Wire Flattening Mills • Chain Draw Benches • Pointers • Swagers • Bull Blocks • String-up • Machines • Spoolers, etc.

Within These Basic WF Equipment Lines, Individual Machines Are Custom-Engineered For Specific Applications

If your metal-working machinery problem falls into any of these five groups, there are good reasons for looking to Waterbury Farrel for the answer.

There's Waterbury Farrel's continuing engineering research with more than a century of machine building experience to draw upon. This results in soundly designed and thoroughly tested features which improve production.

There's Waterbury Farrel's world-wide reputation for rugged, long-lasting construction. This gives you the assurance that WF machines are built to provide long years of uninterrupted production.

Waterbury Farrel can custom-engineer special equipment or adapt a standard machine to fit your specific problem.

For further information, write for free booklets on any of the machines mentioned on this page or contact your nearest WF office.

HERE'S A SAMPLE of Waterbury-Farrel mass production equipment in action. This complete WF automatic production unit combines a 40-ton double-acting, upright blanking and cupping press, a conveyor feed and four 7-station horizontal drawing presses to draw 340 zinc shells per minute.

FOUNDED WATERBURY FARREL 1851

WATERBURY FARREL FOUNDRY & MACHINE CO. • WATERBURY, CONN.

Offices: Chicago, Cleveland and Millburn, N. J.

this man has ice water in his veins!

Of course he'd never volunteer to give blood, anyway. But any resemblance of this old duffer to the average, red-blooded American is a mistake.

For instance, several million healthy Americans have given blood. *But it's not enough.*

So this is to tell several million more Americans that their blood is needed—now!

We've never let anyone down who was in trouble. When a GI gets wounded and suffers *shock*—he's in bad trouble. He's got to have blood and lots of it! Folks here at home need blood too—to save their lives.

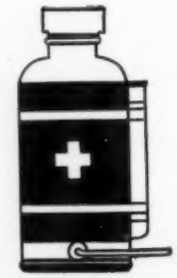
So make a date with your Red Cross, Armed Forces or Community Blood Donor Center. *One* hour and you're on your way.

BUSINESS EXECUTIVES
CHECK THESE QUESTIONS

If you can answer "yes" to most of them, you—and your company—are doing a needed job for the National Blood Program.

- ◯ HAVE YOU GIVEN YOUR EMPLOYEES TIME OFF TO MAKE BLOOD DONATIONS?
- ◯ HAS YOUR MANAGEMENT ENDORSED THE LOCAL BLOOD DONOR PROGRAM?
- ◯ HAS YOUR COMPANY GIVEN ANY RECOGNITION TO DONORS?
- ◯ HAVE YOU INFORMED EMPLOYEES OF YOUR COMPANY'S PLAN OF CO-OPERATION?
- ◯ DO YOU HAVE A BLOOD DONOR HONOR ROLL IN YOUR COMPANY?
- ◯ WAS THIS INFORMATION GIVEN THROUGH PLANT BULLETIN OR HOUSE MAGAZINE?
- ◯ HAVE YOU ARRANGED TO HAVE A BLOODMOBILE MAKE REGULAR VISITS?
- ◯ HAVE YOU CONDUCTED A DONOR PLEDGE CAMPAIGN IN YOUR COMPANY?
- ◯ HAVE YOU SET UP A LIST OF VOLUNTEERS SO THAT EFFICIENT PLANS CAN BE MADE FOR SCHEDULING DONORS?

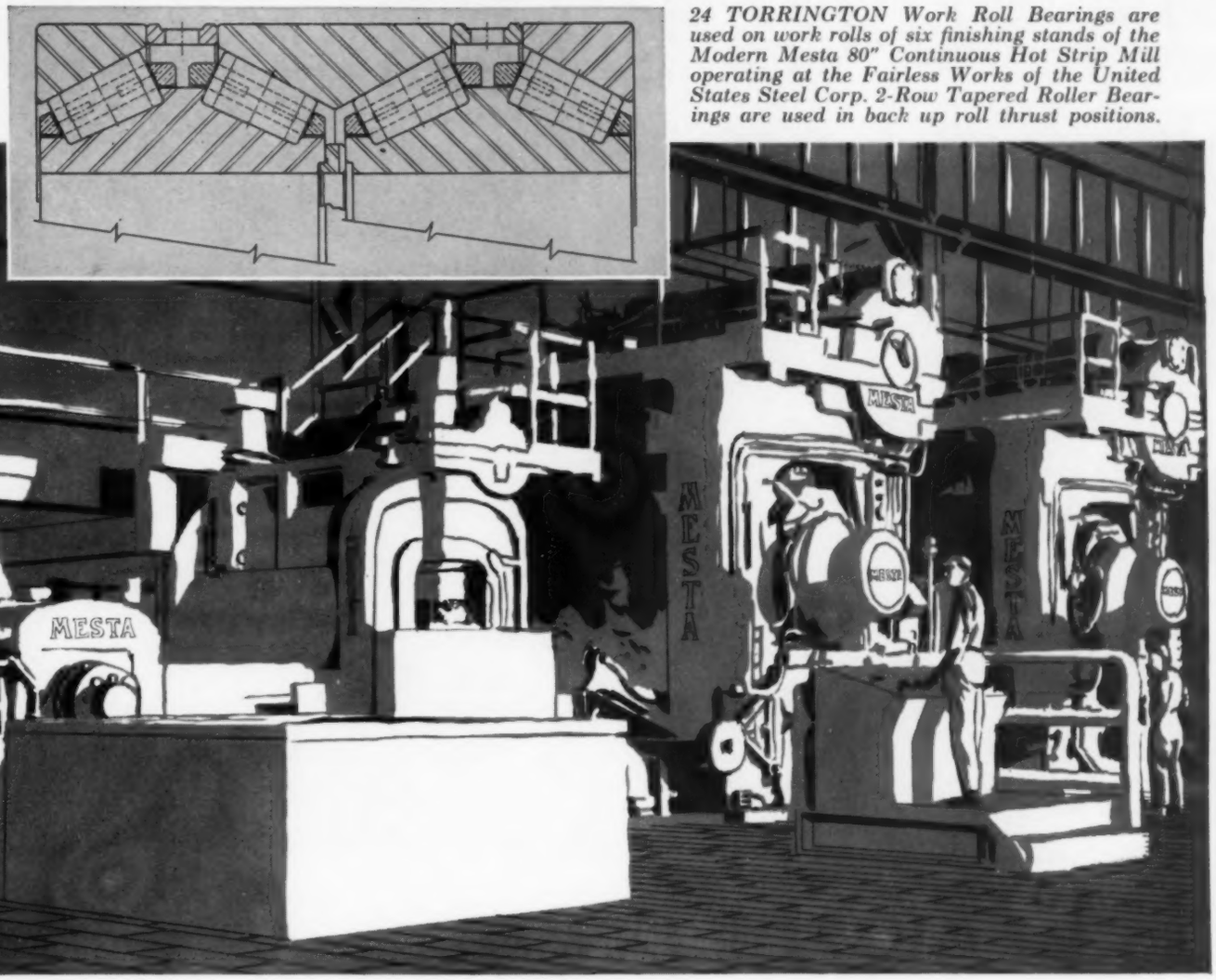
Remember, as long as a **single** pint of blood may mean the difference between life and death for **any** American . . the need for blood is **urgent**!



GIVE BLOOD

...give it again and again

NATIONAL BLOOD PROGRAM



24 TORRINGTON Work Roll Bearings are used on work rolls of six finishing stands of the Modern Mesta 80" Continuous Hot Strip Mill operating at the Fairless Works of the United States Steel Corp. 2-Row Tapered Roller Bearings are used in back up roll thrust positions.

For longer service

Only the finest quality, electric furnace, alloy steel is used in TORRINGTON Work Roll Bearings. The bearings are carefully heat treated and carburized to provide qualities of toughness and hardness, stability and uniformity . . . thereby making it possible for them to withstand the rigors of modern, continuous hot strip rolling. The steep angle construction of the bearings guarantees maximum thrust capacity. One-piece, cast bronze cages for each roller path and machined pads in each roller pocket improve the over-all performance and lengthen bearing life.

Specify TORRINGTON Work Roll Bearings for greater rolling efficiency . . . longer low maintenance service. TORRINGTON bearings are available in a variety of types—including Cylindrical, Tapered and Spherical Roller—capable of handling any combination of thrust and radial load. Call a TORRINGTON engineer for consultation on your bearing problems.

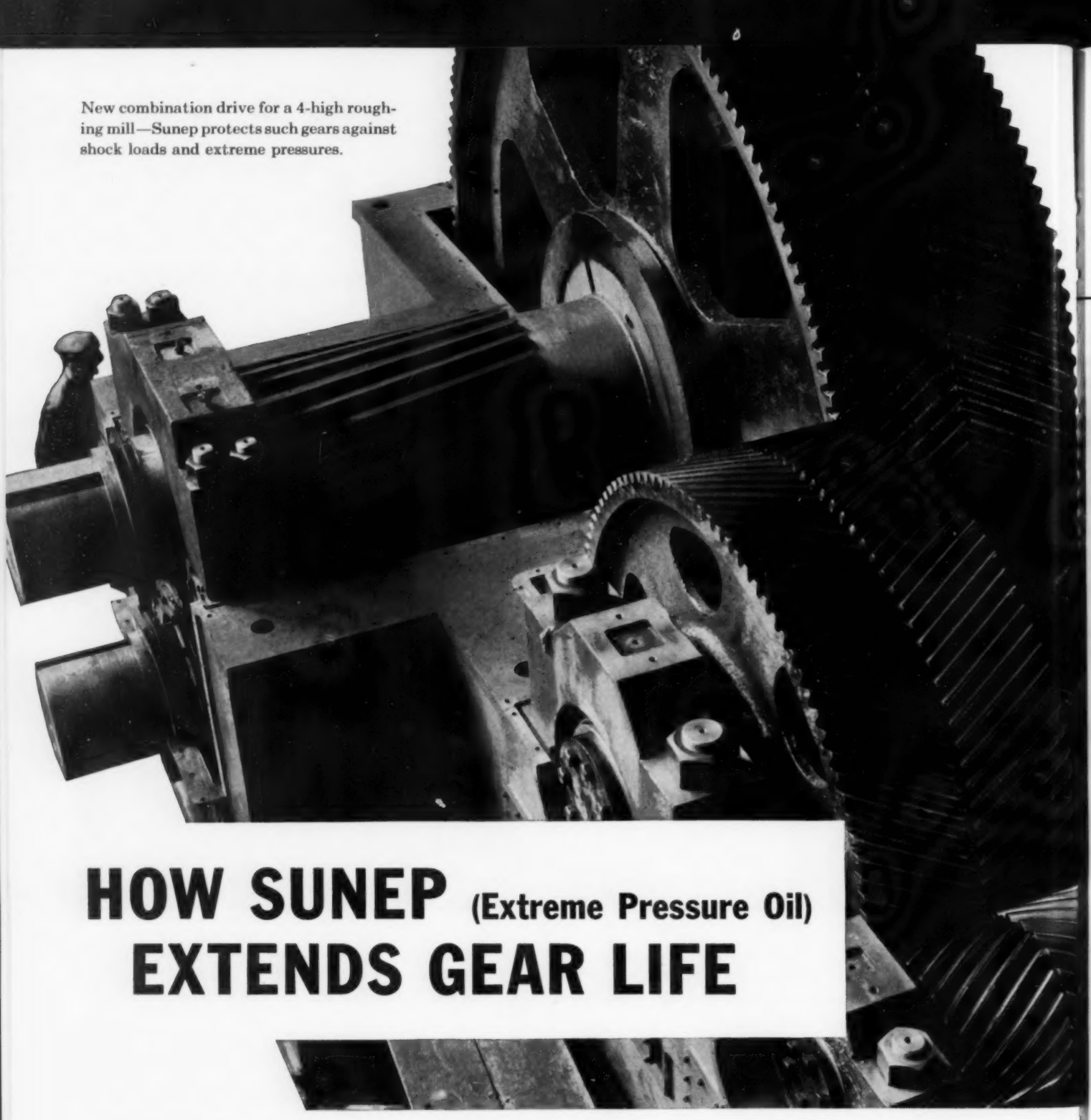
THE TORRINGTON COMPANY
South Bend 21, Ind. Torrington, Conn.

District offices and distributors in principal cities of United States and Canada

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

New combination drive for a 4-high roughing mill—Sunep protects such gears against shock loads and extreme pressures.



HOW SUNEP (Extreme Pressure Oil) EXTENDS GEAR LIFE

The advantage of running your machines at high speeds and under heavy loads can be quickly lost if your extreme pressure lubricants turn thick, lose film strength, or cause gears to corrode.

Sunep gives your gears better protection longer. Unlike many E.P. oils, Sunep is made from highly refined, premium grade oils skillfully blended with chemical additives that do not drop out during operation or in prolonged storage. This accounts for several rare user benefits: long life at extreme pressures; absence of corrosion—even on bronze; rust protection for steel parts; clean gears and bearings as a result of the oil's high stability.

Primarily a lubricant for enclosed gears, Sunep has proven to be highly effective on bearings and screws working under extreme pressures. Because of its exceptional clinging characteristics, Sunep guards against metal-to-metal contact during the early moments of machine operation after shutdown. FREE BULLETIN. Tells all about Sunep. Get your copy. Write Dept. IS-10

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

SUNOCO®

PHILADELPHIA 3, PA. • SUN OIL COMPANY LTD., TORONTO & MONTREAL

Refiners of famous High-Test Blue Sunoco Gasoline

THE ENGINEERING MART

WHERE TO BUY
EQUIPMENT FOR SALE
POSITIONS VACANT
POSITIONS WANTED

AN *IRON and STEEL ENGINEER* SERVICE TO THE STEEL MILL OPERATORS

WHERE TO BUY

BIRMINGHAM DISTRICT

DIXIE ENGINEERING COMPANY
"Manufacturer's Agents"
P. O. Box 750 — 812-813 Protective Life Building
BIRMINGHAM 3, ALABAMA
Sabel E. Baum — Telephone 4-0417

CHICAGO DISTRICT

PAUL W. WENDT & SONS
Manhattan Building
CHICAGO 5, ILLINOIS
District Representatives for
A. W. CADMAN MFG. CO.
HUNTER SAW & MACHINE CO.
GRAFO COLLOIDS CORP.

EHRET AND KINSEY
Board of Trade Bldg., 141 West Jackson Blvd.
Chicago 4, Illinois — Wabash 2-0449
Representing
THE CLEVELAND WORM AND GEAR CO.
"Cleveland" Worm Gearing and Worm Gear Speed Reducers
THE FARVAL CORPORATION
"Farval" Centralized Lube Systems
LUBRICATION PRODUCTS COMPANY
"Stapax" Journal Box Lubricators
AMERICAN FLEXIBLE COUPLING COMPANY
"Amerigear" Flexible Couplings
WALDES KOHINOOR, INCORPORATED
"Truarc" Retaining Rings
2400 W. Clybourn St. — Phone:
Milwaukee 3, Wisc. — Division 2-7844

PITTSBURGH DISTRICT

ROLLING MILLS and EQUIPMENT
FRANK B. FOSTER, INC.
2220 OLIVER BUILDING PITTSBURGH 22, PA
Cable Address "FOSTER" Pittsburgh

METALLIC RECUPERATORS
(Air Preheaters)
For application to soaking pits, heating, and other types of metallurgical furnaces.
HAZEN ENGINEERING CO.
Park Building — PITTSBURGH, PA.
COurt 1-7032

ELECTRICAL INSTALLATIONS
PATTERSON EMERSON COMSTOCK, INC.
PITTSBURGH, PA.
STEEL MILLS—INDUSTRIALS UTILITIES
313 EAST CARSON ST. — ZONE 19

AUBURN AND ASSOCIATES, INC.
ENGINEERS
COMPLETE
ENGINEERING . DESIGN . LAYOUT
FOR
STEEL MILLS AND HEAVY INDUSTRY
923 Penn Ave., Pgh. 22, Pa.
Telephone COurt 1-5014

W. G. KERR CO., INC.
520 Oliver Building — PITTSBURGH, PA.
Phone: ATlantic 1-4254
Representing:
FOOTE BROS.—Gears and SpeedReducers
REEVES—Variable Speed Drives
THOMAS—Flexible Couplings
WICHITA—Air Tube Disc Clutches & Brakes
TELSMITH—Telsmith Crushers
CULLEN-FRIESTEDT—Sheet Lifters—Welding Positioners—Track Cranes

CHEMSTEEL CONSTRUCTION COMPANY, INC.
204 Chemsteel Bldg., Walnut St., Pittsburgh 32, Pa.
Send data on Engineering & Construction facilities for
ACID-ALKALI-PROOF CONSTRUCTION
of pickling and other tanks; flooring.
(TEAR OUT & MAIL WITH LETTERHEAD)

RITTER ENGINEERING CO.
Engineers - Distributors - Contractors
1515 WEST LIBERTY AVE. — Phone:
PITTSBURGH 26, PA. — LOCUST 1-1303
Representing:
TRABON ENGINEERING CORP.
"Centralized Lubricating Systems"

CONSULTING ENGINEERS

ROSS E. BEYNON
Consultant
ROLLING LAYOUT AND ROLL DESIGN
7658 Coles Avenue — Chicago 49, Illinois
Telephone SAginaw 1-3466

LOYAL R. MILBURN
Consulting Electrical Engineer
Registered State of Michigan
1928 Guardian Building • Detroit 26, Michigan
Telephone: Woodward 3-8706 or Whitmore Lake 5141

W. VANCE MIDDOUGH & ASSOCIATES
Consulting Electrical Engineers
Engineering • Design • Layout
Heavy Industrial Power & Light
204 Columbia Building .. Cleveland 15, Ohio
Prospect 1-2060

HOUSER AND CARAFAS ENGINEERING CO.
Engineering for Industry
969 Liberty Avenue -:- Pittsburgh 22, Pa.
Phone: GRant 1-9929

PRODUCTS

MODERN
MILL OPERATORS' PULPITS
DESIGNED BY
WALLACE F. SCHOTT
CONSTRUCTED BY
JAMES CAMPBELL SMITH, INC.
WILLOUGHBY OHIO

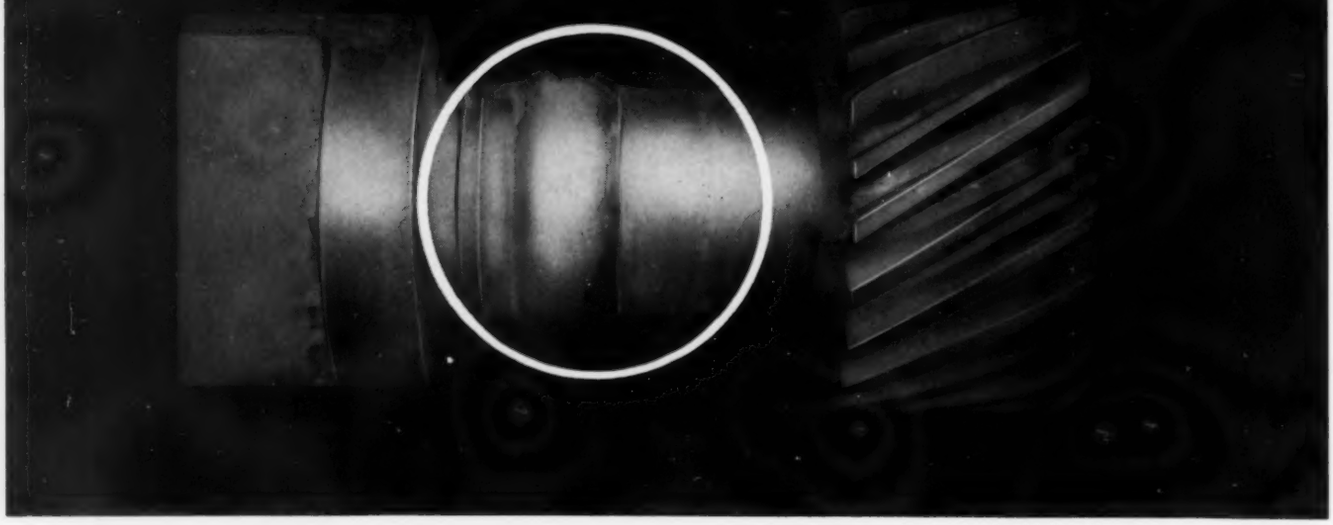
POSITIONS VACANT

STEEL MILL ENGINEER
Broad background in blast furnace, open hearth, strip mill plant and machinery design. Ten years experience in engineering and drafting supervision. Nine years in plant operations. Age 40. M. E. degree. For details write Box 1001, Iron and Steel Engineer, 1010 Empire Bldg., Pittsburgh, 22, Pa.

THE COST OF AN AD THIS SIZE IS $8.00 PER INSERTION

Here's where

THERMIT WELDING STOPPED THE CLOCK!



Weeks of idle time saved in returning pinion to duty...

When a piece of vital equipment breaks down, Thermit Welding stops the clock on idle time — enables quick, economical repairs on a variety of parts. Only a *minimum* of technical skill is required.

See the time-saving repair made on the 48" mill pinion shown above. The 28" neck was Thermit welded — and the pinion was back in operation *weeks* before a replacement could be obtained.

WAITING FOR REPLACEMENT PARTS COSTS TIME AND MONEY!

USE THERMIT WELDING

ALWAYS READY TO WORK FOR YOU

METAL & THERMIT CORPORATION

100 EAST 42ND STREET • NEW YORK 17, N. Y.

Newark, N. J. • Pittsburgh, Pa. • E. Chicago, Ind. • So. San Francisco, Cal. • Philadelphia, Pa • Toronto, Canada

INDEX TO ADVERTISERS

OCTOBER, 1954

A

Adalet Manufacturing Co. 164
Aetna-Standard Engineering Co. 28, 29
Ajax Flexible Coupling Co. 178
Aldrich Pump Co., The 176
Alliance Machine Co. 10
Allis-Chalmers Manufacturing Co. 4, 5
American Air Filter Co. 17
American Brake Shoe Co., Electro-Alloys Division 14
American Brake Shoe Co., National Bearings Division 25
American Bridge Division, United States Steel Corp. 45
American Wheelabrator and Equipment Corp. 181
Ampco Metal, Inc. 50
Askania Regulator Co. 8

B

Bedford Foundry and Machine Co. 149
Birdsboro Steel Foundry and Machine Co. 31
Blaw-Knox Co., Machinery Division 26
Blaw-Knox Co., Rolls Division 52
Bliss Co., E. W. 37
Bonnot Co. 152
Bristol Co., The 192
Brooks Oil Co. 198
Browning and Co., Inc., Victor R. 144

C

Carborundum Co., The 135
Cities Service Oil Co. 30
Clark Controller Co. 6
Clark Equipment Co., Ross Carrier Line, Industrial Truck Division 165
Cleveland Crane and Engineering Co. 48
Cleveland Quarries Co., The 171
Cleveland Worm and Gear Co. Cover 3
Columbus McKinnon Chain Corp. 167
Continental Foundry and Machine Co. 7
Crane Co. 136
Crouse-Hinds Co. 139
Cunningham Co., M. E. 187
Cutler-Hammer, Inc. Cover 2

D

De Laval Steam Turbine Co. 201
Diamond Power Specialty Corp. 208
Documentation and Licenses, Paris, France 193, 194, 195, 196
Dowell, Inc. 146
Dravo Corp. 190
Drever Co. 39
Duraloy Co., The 200

E

Electric Controller and Manufacturing Co. 3, 34, 145
Electric Furnace Co., The 177
Electric Service Manufacturing Co. 153
Elliott Co. 46, 47
Enterprise Co. 168

F

Farrel-Birmingham Co., Inc. 21
Flinn and Dreffein Engineering Co. 193, 194, 195, 196
Flower Manufacturing Co., D. B. 212

G

Garlock Packing Co., The 156
General Motors Corp., Hyatt Bearings Division 132
Gulf Oil Corp. 9
Guyan Machinery Co. 206

H

Hallden Machine Co. 193, 194, 195, 196
Harbison-Walker Refractories Co. 143
Harnischfeger Corp. 38
Heyl and Patterson, Inc. 210
Houghton and Co., E. F. 162
Hyde Park Foundry and Machine Co. 211

J

Johns-Manville Corp. 151

K

Kaiser Aluminum and Chemical Corp. 22
Koppers Co., Inc. 157, 174, 175, 185

L

Lake Erie Engineering Corp. 15
Lassman and Son, Benjamin 18
Linde Air Products Co., Division of Union Carbide and Carbon Corp. 1
Link-Belt Co. 11
Lintern Corp., The 183

M

Mackintosh-Hemphill Co. 154, 155
Mannesmann-Meer Engineering and Construction Co. 161
Manning, Maxwell and Moore, Inc., Shaw Box Division 40
McKiernan-Terry Corp. 170
Medart Co., The 163
Mesta Machine Co. Cover 1
Metal and Thermit Corp. 218
Michigan Tool Co., Cone-Drive Gears Division 207
Miles and Partner, John (London, Ltd.) 193, 194, 195, 196
Minneapolis-Honeywell Regulator Co. 32, 33
Morgan Construction Co. 43
Morgan Engineering Co. 35
Murray Manufacturing Co., D. J. 184

N

National Carbon Co., Division of Union Carbide and Carbon Corp. 172
National Roll and Foundry Co., The 2
Northern Engineering Works 160

O

Ohio Steel Foundry 158
Okonite Co., The 20

P

Pennsylvania Transformer Co. 166
Pittsburgh Lectromelt Furnace Corp. 54
Pollock Co., William B. 189
Poole Foundry and Machine Co. 191
Post-Glover Electric Co. 51
Pyle-National Co., The 187

R

Ramtite Co., The 131
Refractory and Insulation Corp. 220
Reliance Electric and Engineering Co. 202
Republic Flow Meters Co. 173
Roberts and Schaefer Co. 205
Rockbestos Products Corp. 140
Rosedale Foundry and Machine Co. 203
Rowan Controller Co. 150
Rust Furnace Co. 125
Rust-Oleum Corp. 186

S

Stamco, Inc. 184
Standard Boiler and Plate Iron Co. 182
Stearns Magnetic, Inc. 126
Sun Oil Co. 216
Svenska Telegrambyran, A/B 16

T

Taylor Chain Co., S. G. 187
Taylor Sons Co., The Charles 12
Texas Co., The Cover 4
Timken Roller Bearing Co., The 41
Torrington Co., The, Bantam Bearings Division 215

U

Union Carbide and Carbon Corp., Linde Air Products Co. 1
Union Carbide and Carbon Corp., National Carbon Co. 172
United Engineering and Foundry Co. 19
United States Graphite Co. 44

W

Wagner Electric Co. 42
Wapakoneta Machine Co. 169
Waterbury Farrel Foundry and Machine Co. 213
Wean Engineering Co. 193, 194, 195, 196
Wean Engineering Co. of Canada, Ltd. 193, 194, 195, 196
Wean Equipment Corp. 193, 194, 195, 196
Webb Co., Jervis B. 13

Y

Yoder Co. 204
Youngstown Alloy Casting Corp. 129
Youngstown Foundry and Machine Co., The 36
Youngstown Welding and Engineering Co., The 188

EXPERIENCE PROVES IT BEST BY FAR

for BLAST FURNACES
COKE OVENS • SOAKING PITS
ANNEALING FURNACES

SUPER #3000 Bonding Mortar

The "Wonder Cement" that steel mills have standardized on for best resistance at high or low temperatures

SETS HARDER

BONDS STRONGER

LASTS LONGER under severe service

Mill after mill is making terrific savings in refractory costs because of the remarkable range of usefulness and durability of Super #3000.

This ready-to-use, plastic mortar bonds brick-to-brick joints of weld-tight resistance to shrinkage, spalling, abrasion and wear.

As a surfacing and sealing wash coat, Super #3000 is practically impregnable, adding service life to existing refractories, cutting down-time to a minimum.

For hot patching, Super #3000 renews existing refractory construction and adds useful life; otherwise complete replacement would be necessary.

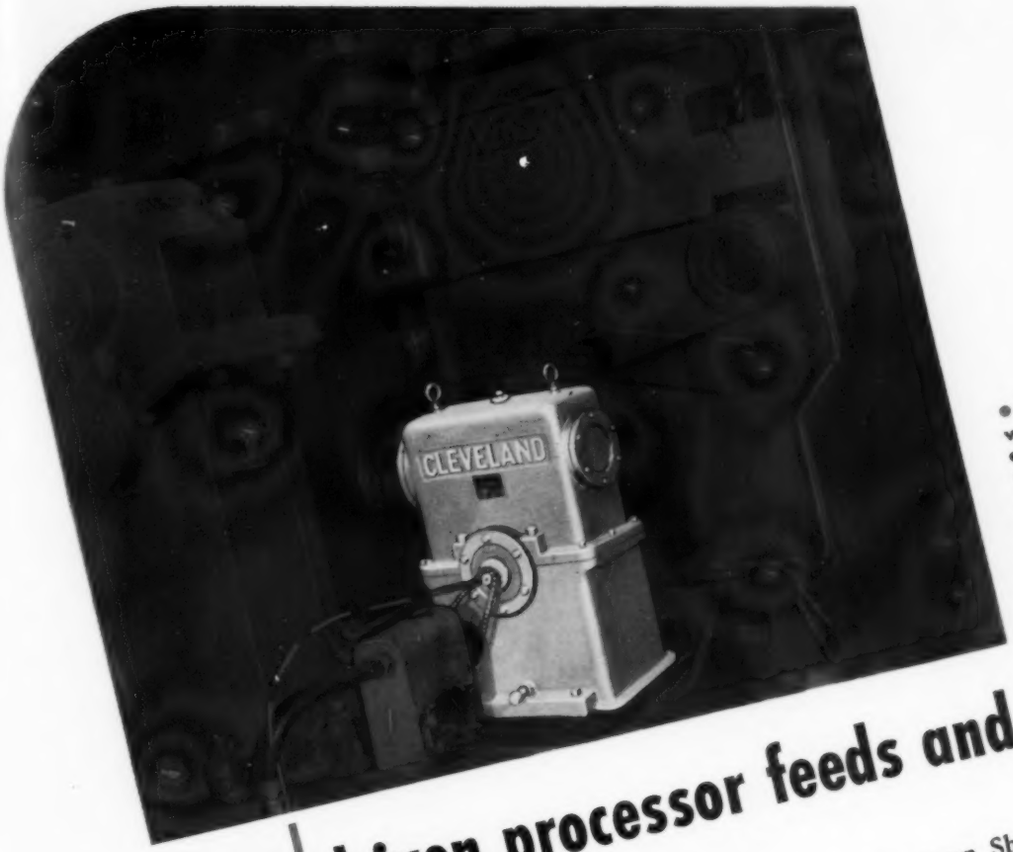
There's simply no bonding mortar to match Super #3000 for effectiveness. It can be troweled, dipped, brush coated or sprayed—and air set—to full effective strength. None matches it for lasting quality.

Get the full Super #3000 service story. It will amaze you.

REFRACTORY & INSULATION CORPORATION

R&I Refractory Bonding and Castable Cements — Insulating Block, Blankets, Cements

136 WALL STREET • NEW YORK 5, N. Y.



● **WORM GEARING**—universal in its application—affords advantages for almost every power transmission job. Whether you want worm gearing sets or speed reducer units, you will find drives to meet your need in the complete Cleveland line.

CLEVELAND-driven processor feeds and levels strip

IN the continuous pickling line at Youngstown Sheet and Tube's new cold reduced sheet mill at Indiana Harbor, this processor levels out the bulges and feeds hot rolled strip to the next station. Efficient performance of both jobs depends largely on the Cleveland drive. Operating from a motor and gear box, the Cleveland worm gear speed reducer drives both tension and leveler rolls of the leveler with a smooth, quiet, steady, torque flow. Ratio is 30:1.

Through 40 years Clevelands have demonstrated the inherently high shock load resistance of quality worm gearing. Worm action on gear teeth is such that, even when severely over-loaded, the danger of sudden failure is remote.

When you install a Cleveland you can be sure you are investing in the finest, most dependable worm gear drive to be had. Write for free Catalog 400. The Cleveland Worm and Gear Company, 3278 East 80th St., Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers

A ROLLING MILL GATHERS A PROFIT...

ONLY WHEN all the techniques of efficient production are employed, can your mill roll at a profit. These techniques include effective lubrication — and Texaco's steel mill experience, its facilities and made-for-the-job lubricants, can be of profitable assistance to you.

Steel men find, for example, that *Texaco Meropa Lubricant* — with special Extreme Pressure properties — gives outstanding protection to enclosed reduction gears and bearings. Similarly, *Texaco Regal Oil* — a heavy, turbine-quality circulating oil with high oxidation-resistance — protects oil film bearings on roll necks.

For the steel industry, there is a complete line of Texaco Lubricants backed by famous Texaco Lubrication Engineering Service. Find out how they can gather a profit for *your* mill. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

☆ ☆ ☆

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Lubricants, Fuels and Lubrication Engineering Service

TUNE IN . . . TEXACO STAR THEATER starring JIMMY DURANTE or DONALD O'CONNOR on television . . . Saturday nights, NBC.